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AMERICAN JOURNAL OF OPTOMETRY and ARCHIVES of AMERICAN ACADEMY OF OPTOMETRY

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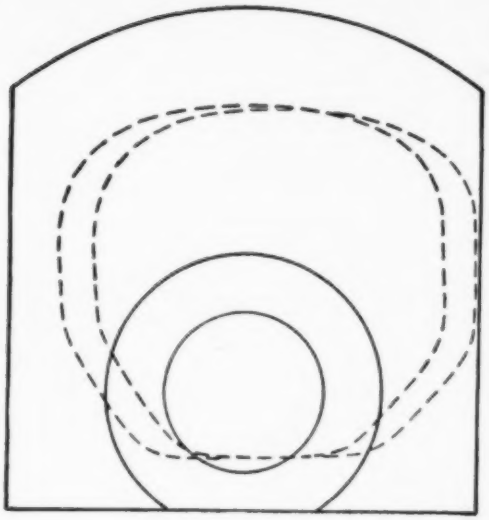

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Vol. 24 — No. 9

CONTENTS

ORIGINAL PAPERS — PAGE

An Investigation of the Use of Stereoscopic Targets in Orthoptics. Meredith W. Morgan 411

Squint—The Psycho-Physiological Aspects Involved in Its Treatment. Milton N. Chodroff 433

High Exophoria At Near Point—A Case Report. Donald A. Springer..... 438

The Extra-Ocular Muscles—Their Functional Requirements and Nervous Control. Gilda Coppola..... 443

The Use of Contact Lenses For An Adolescent Patient—A Case Report. John J. Wey..... 451

EDITORIALS 452

CURRENT COMMENTS 454

ANNOUNCEMENTS 458

SPECIAL REPORT

The American Optometric Foundation. William C. Ezell..... 461

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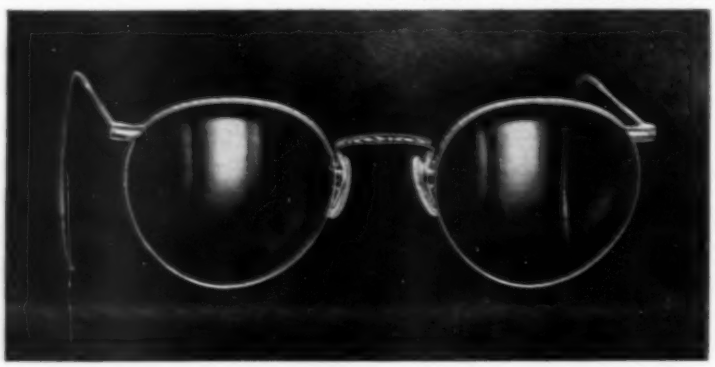

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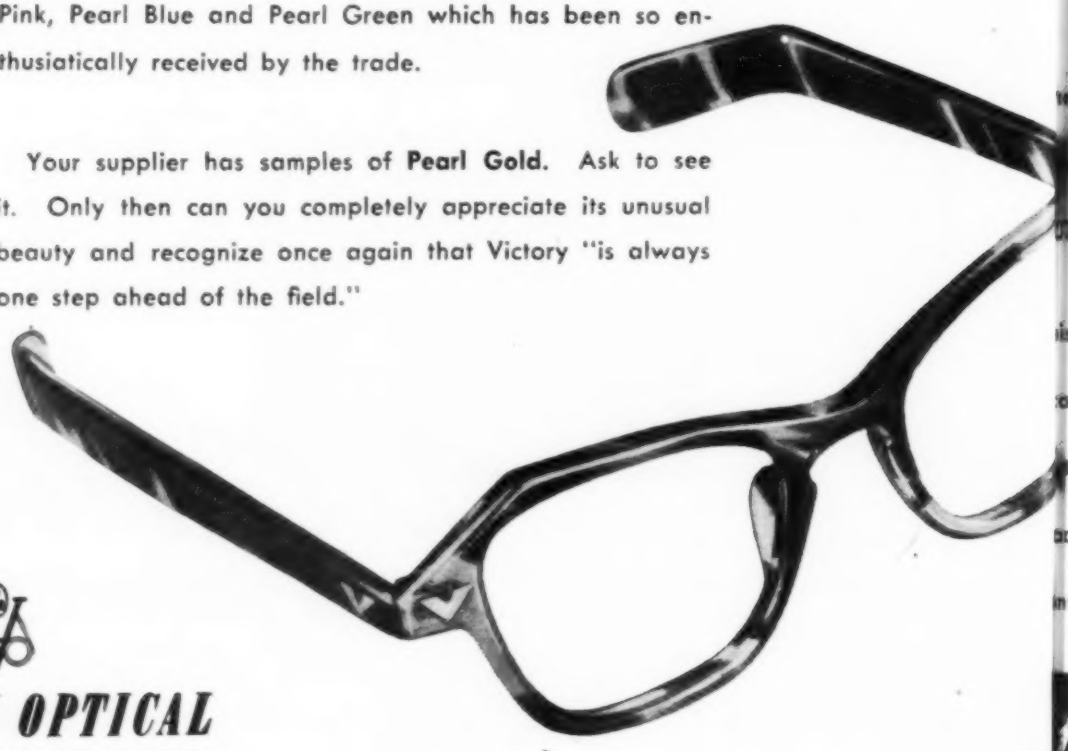

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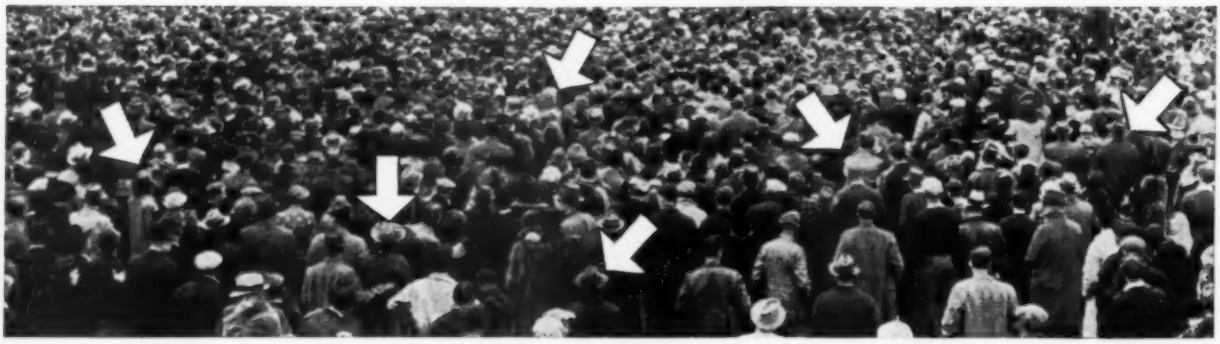

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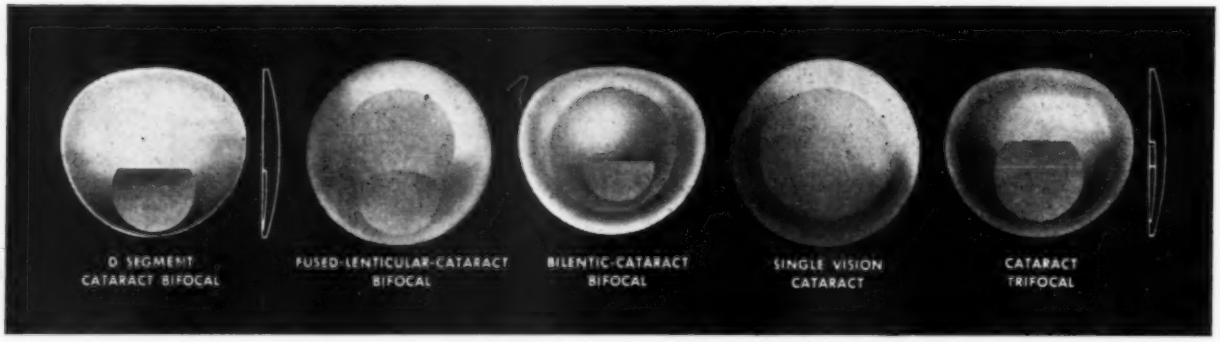

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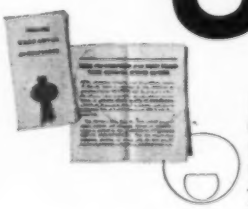

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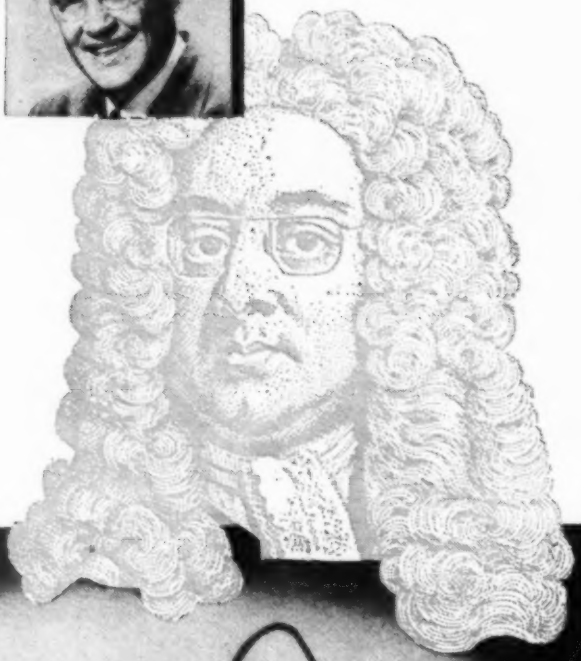

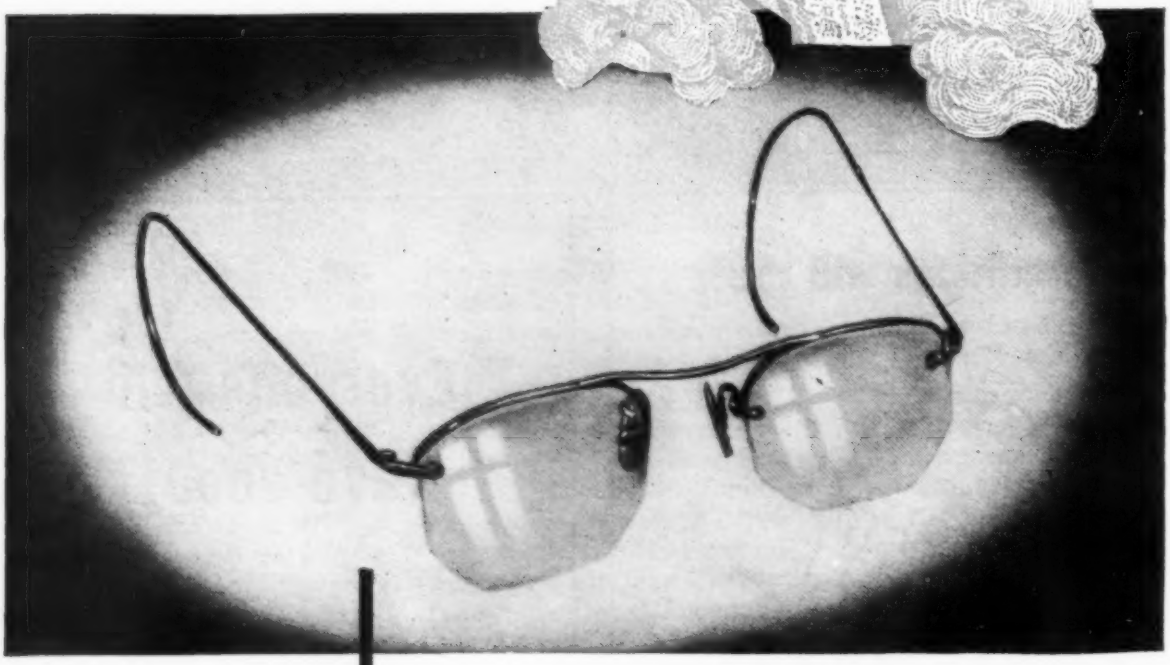

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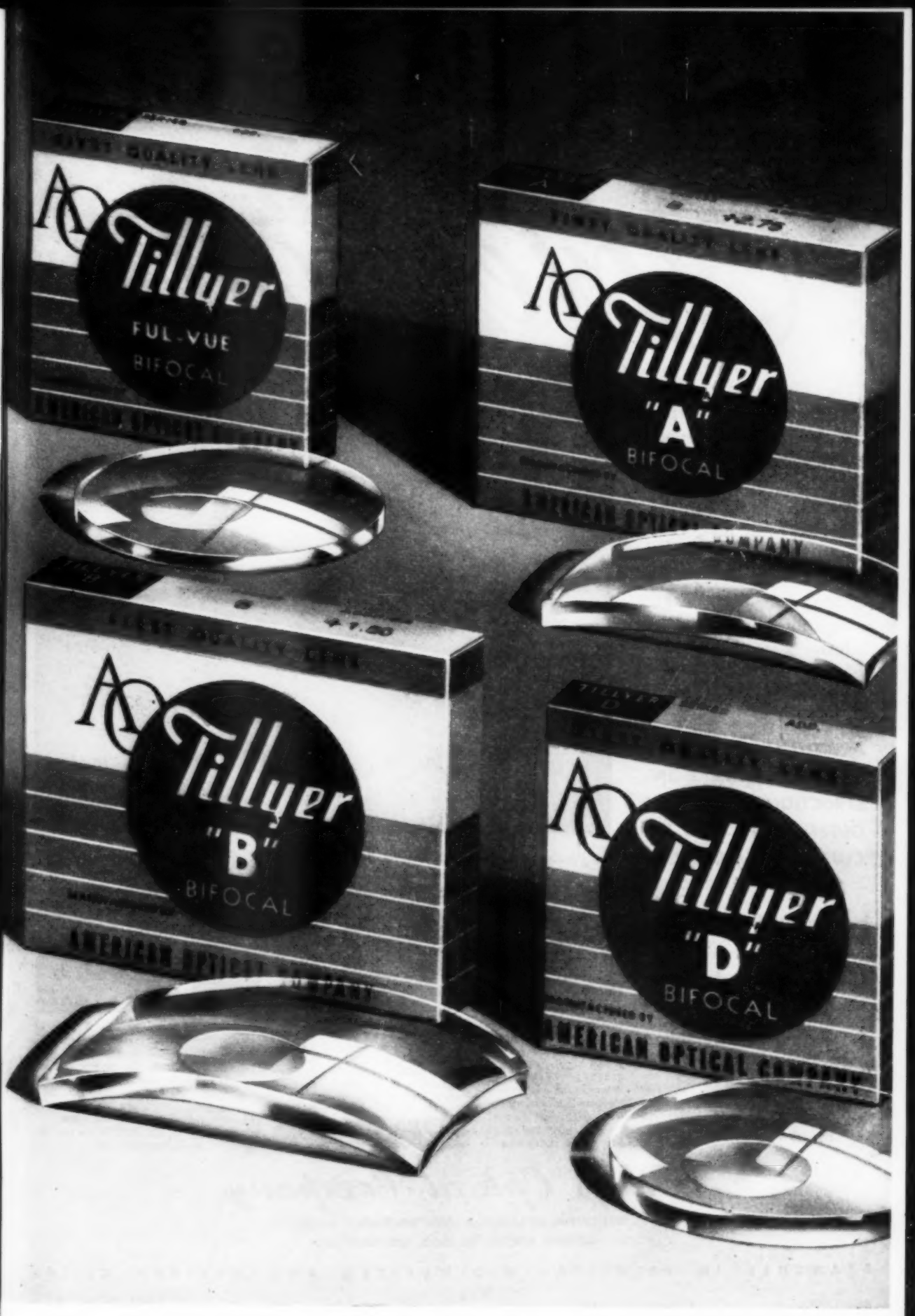
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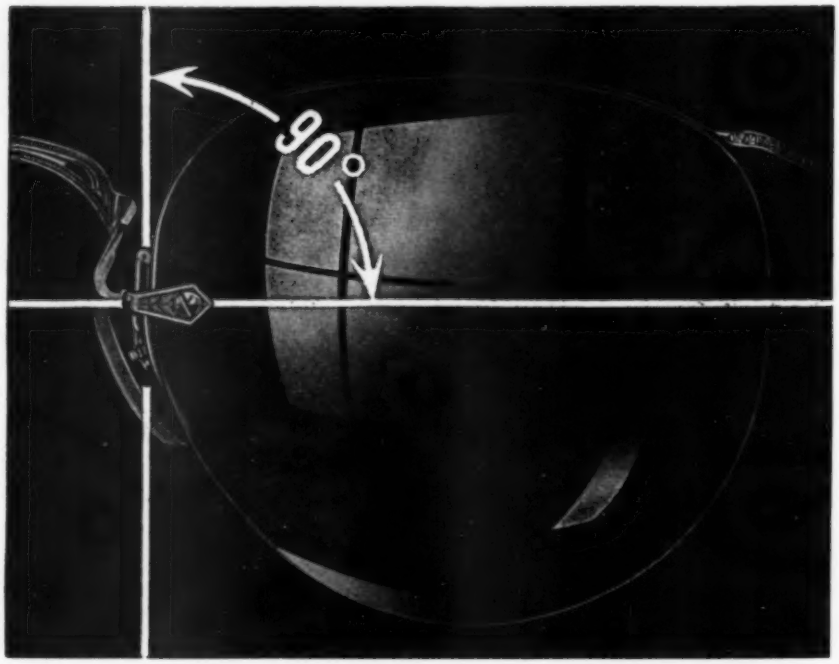

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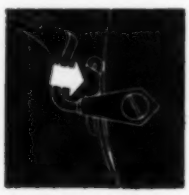

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Vol. 24 SEPTEMBER, 1947 No. 9

AN INVESTIGATION OF THE USE OF STEREOSCOPIC TARGETS IN ORTHOPTICS*

Meredith W. Morgan, Jr.†
School of Optometry, University of California
Berkeley, California

Orthoptics is a specialized field of optometry that has been variously defined. It is becoming more and more customary to apply the term orthoptics to various training methods dealing with squint while using some such term as visual training to describe methods used when the subject does not have an actual deviation of the eyes. Lyle[1] has defined orthoptics as ". . . the name given to that branch of ophthalmology which deals with the correction of squint (both manifest and latent), and other abnormalities of the binocular functions by means of special exercises designed to produce comfortable binocular vision." Lancaster[2] takes an even broader point of view and says that orthoptics deals with defective habits of seeing, defects of binocular vision and defects of ocular motility. The broader view as expressed by Lancaster will be taken in this paper. Orthoptics is not limited to squint.

Strangely enough it is in the field of squint that orthoptics is becoming more and more stabilized. This branch of orthoptics is almost reaching the more formalized state of established practices and procedures. However, in the field of non-squinters, orthoptics seems to be in a rather chaotic state. This condition is so bad that Ryer & Hotaling[3] have remarked, ". . . . much of the treatment accorded ocular motor anomalies has been based upon superficial, if not basically unsound, premises. In no other branch of optometry and ophthalmology have

*This investigation made possible by a grant-in-aid from the American Academy of Optometry. Submitted on April 20, 1947, for publication in the September, 1947, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Optometrist. Fellow, American Academy of Optometry. Assistant Professor of Optometry.

glib talkers, fanciful writers, fantastic hypotheses, unwarranted claims and overrated instruments been so uncritically accepted as in that of orthoptics. Such general acceptance of superficiality denotes a general lack of fundamental knowledge . . ."

Ocular motility and coordination of visual functions are necessary because the retina is not uniformly sensitive. We must turn our eyes in critical seeing so that the image on each retina falls upon the foveal area of each eye. This is an elementary, but basic, requirement for normal binocular function which is forced upon us by the anatomical structure of our eyes. "Obviously an eye can get away with having a fovea only if it can be aimed precisely at the object of momentary regard, by the coordinated actions of the extra-ocular muscles."[4] In spite of the fact that bifoveal vision is a primary requisite imposed by anatomy, we find such statements in the literature as the following, "Our main objective is the restructuring of perceptual fields. To do this we must by-pass the eye itself in order to create within the central mechanism a new pattern."[5] The point should be made that it is the eye that acts as the first link in the chain of vision and it is the eye that as the last link moves as a result of any motor impulse that is made in the interest of foveal vision. Of course perception is vastly more complicated than mere seeing with the fovea. Perception implies a great many psycho-physiological processes of an integrative and analytical nature not at once apparent in the object, eye, retinal image and mental image chain, but basically motility is a prime requisite only when a fovea exists.

One also frequently finds in the literature a confusion as to acquired and inherent characters. Many writers seem to give the impression that if a character is not present at birth or shortly thereafter, that any subsequent appearance of it puts the character in the category of an acquired one. There are a great many characters inherent in the organism at birth that are a long time in making their appearance. For example, all those factors associated with sex await puberty for full development. Visual functions are not physiologically developed at birth, or even shortly thereafter, because the visual mechanism is not anatomically developed. As anatomical development proceeds, so does physiological coordination proceed. As physiological development proceeds, there are certain modifications that arise as a result of experience. These modifications, which arise from experience are the acquired characters. It is often extremely difficult, if not impossible, to separate them from ones inherent in the organism. The fact is that inherent and acquired factors develop together and both must be taken into account. Neither is more

important than the other save in the sense that a character must be present anatomically and physiologically first before it can be altered by experience. Seeing is impossible in a human being without eyes. It is the writer's firm conviction that both the functionalists and the nativists are building foundations on sand. There is a common saying to the effect that you cannot make a silk purse out of a sow's ear, but it is equally true that you must do something to the silk before it becomes a purse.

This differentiation often becomes important in orthoptics. Frequently an inadequate adaptation is made by an individual to some anatomical or physiological anomaly. The question immediately arises as to whether the basic anomaly may be corrected or whether the subject may not be taught to adequately compensate. Most frequently the latter is the course taken. An example is amblyopia. This is generally divided into congenital amblyopia and amblyopia ex anopsia. The anopsia form responds to treatment while the congenital does not. If it were possible to differentiate accurately, much time, effort and funds could be saved. Since this differentiation is virtually impossible, all amblyopia, except in obvious pathological cases, must be treated as anopsia. However, the practitioner must always keep in mind that this particular difficulty may be inherent and not acquired.

Myopia is a good example of a defect that may be either functional or developmental. The actual number of functional cases appears small and most attempts to reduce developmental myopia end up, not in overcoming the nearsightedness, but in enabling the subject to functionally become more compensated to being myopic.[6] The myopia is not reduced by training but measurable visual acuity is slightly increased.

Of equal importance with motility of the eye in binocular vision is the phenomenon of fusion. Here again the debate becomes very heated as to whether fusion is innate or acquired. It would appear that the possibility of fusion is innate. There are various points in each retina whose simultaneous stimulation gives rise to a unitary response. These points are characterized by identical visual direction and are called corresponding points. Around each, there is a small area called Panum's area in which a stimulus may be applied which will give rise to a single sensation, but the location of the stimulus will be displaced and stereopsis will result if the stimulus is in the area but not on corresponding points. Under very special conditions new reference points may be established either momentarily or somewhat permanently. This is known as anomalous correspondence. More frequently a secondary correspondence

appears to be set up, as for example when space perception returns to apparent normality after wearing a size lens for some time. However, as Burian[7] has pointed out, this apparent secondary correspondence entirely disappears in a situation in which the normal space clues are lacking. The subject wearing a size lens does not change the correspondence but becomes adequately adapted to a new set of conditions. In the orthoptics of strabismus in which anomalous correspondence is a basic problem, it is frequently found that the apparent change in correspondence entirely disappears as the area of neutralization disappears. Again we have the situation of a functional adaptation masking a normal innate condition. For a more complete discussion of correspondence the reader is referred to the work of the Dartmouth Eye Institute.[8]

Accommodation plays an important role in normal binocular vision along with motility and fusion. Not only must the retinal image be placed on each fovea, which are normally corresponding areas, by movements of the eyes, but the image must be fairly sharp for critical seeing. Exact focus is not necessary as the eye has a certain depth of focus, but there are definite limits of blurredness within which exacting vision is possible. This sharp image is maintained on the fovea by accommodation. If accommodation were merely called upon to make the image sharp, the situation would be simple. However, accommodation is associated with ocular motility so that whenever accommodation is called into action the visual lines tend to converge. If fusion is suspended, the visual lines do converge. This movement is called accommodative-convergence. It has been critically investigated by Fry[9, 10], Hofstetter[11, 12, 13], and Morgan[14, 15] in recent years. The results of these investigations on all types of subjects and by different methods of approach are almost identical. Subjects with and without binocular vision all have a relationship that closely approximates 4△ of convergence for each diopter of actual accommodation. If the range is extended from 2△ to 6△ of change in convergence for each diopter of accommodation some 84 per cent of all subjects is included. No other reflex movement of the body except for the very simple and direct ones like the knee jerk and pupillary change with brightness are as precisely defined. Like such reflexes as the knee jerk it cannot be inhibited by will. As far as the writer can determine there is no substantiated record of it ever having been changed in value. If we assume that the photographs of Miss Ling[16], are correct (no one doubts that they are), they do not prove that this is a learned reflex. These pictures do not measure accommodation, for example. But even more fundamental, this reflex does not

have to appear in any particular place in time. It may be one of the innate reflexes which is late in making its appearance.

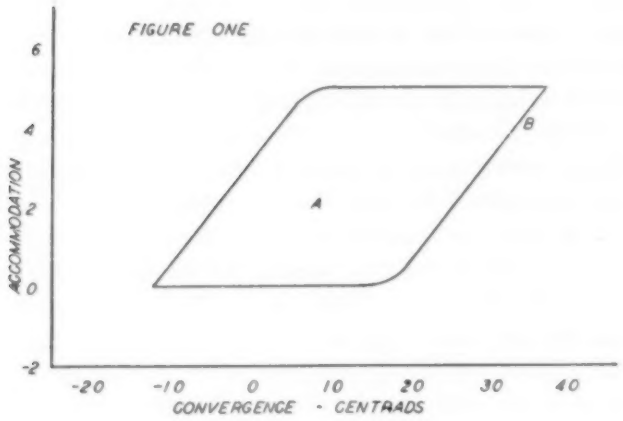
In contrast to the condition in which a change in accommodation always causes some change in convergence, there are possible changes in convergence which do not go hand in hand with a change in accommodation. This convergence is termed relative convergence.[9, 10, 12, 14, 17] Normally the magnitude of relative convergence has a definite limit which is susceptible to clinical measurement. However, the limits positively and negatively are not rigidly fixed and may readily be extended, particularly the positive one, by orthoptic procedures.

Accommodation, like relative convergence, is also limited. In this case the limiting factors are apparently not functional as a rule. The phenomenon of presbyopia is too well known to need further discussion.

Acting in a similar manner to accommodative-convergence is proximal-convergence.[11, 14] As the attention is changed from a distant object to a near object or vice versa, certain changes occur in convergence that can be separated from accommodative and fusional convergence. This convergence seems to be related to the subject's concept of the distance to the fixated object. In contrast to accommodative-convergence, this reflex has all the properties of an acquired one; it varies over a relative tremendous range from individual to individual and in the same individual from time to time, and it is readily changed by training.

All of these factors: motility, fusion, accommodation, accommodative-convergence, relative convergence, and proximal convergence act together in any situation of single binocular vision. These functions and their limits for any one individual may be plotted graphically. In which case, a more or less parallelogram figure results called the zone of single binocular vision. Within the boundaries of this parallelogram, single clear binocular vision is possible. However, the zone of single clear comfortable binocular vision is considerably more limited. Exactly how much one must shrink these limits of the zone of single binocular vision to add the word comfortable to its description varies from individual to individual and from visual task to visual task. Empirically a two-thirds reduction seems satisfactory so that the limit in any direction from the point of demand should be at least three times the demand.

The most exacting and critical investigation of the size and shape of the zone of single vision is that of Hofstetter's.[12] An idealized zone is shown in Figure 1. Horizontal measurements indicate relative convergence. While it is not strictly true, vertical measurements indicate "relative accommodation." Diagonal measurements indicate changes in



the fixation distance. For example, if one wishes to arrive at the limit of positive relative convergence from point A which has a fixation distance of 2.0 D or a 0.5 meter, one can add about 15△ base out, or one can add —2.00 D.S. increasing accommodation to 4.00 D and then add about 25△ base out, or one can add +1.00 decreasing accommodation to 1.00 D and then add about 13△ base out, or one can change the fixation distance and add about 15△ base out. This does not follow exactly because the vertical distance is not strictly relative accommodation.

According to Hofstetter it has been determined that:

1. There is no characteristic variation in the zone dependent on the type of ametropia.
2. The slope of the limits of the zone cannot be changed by training.
3. There is no change in the slope of the zone with age.
4. The zone can be enlarged horizontally by training.
5. Changes in the width of the zone have no effect on phoria.

Careful reading will disclose that if the width of the zone at a fixation distance of one meter is affected; then the same increase will be observed at all other fixation distances, otherwise a change in slope will result. Anticipating the results reported in this paper a little, the writer wishes to state that he is in complete agreement with Hofstetter at this point.

In the discussion above it has been repeatedly mentioned that innate and acquired reflexes are involved in binocular vision and that also one may become adequately adapted or compensated to some

anomaly. Thus, in considering a situation in which the point of demand is not within the middle third of the zone of binocular vision there are two obvious methods of attack. The point of demand may be moved into the middle third of an existing zone or the width of the zone might be increased, which will in turn enlarge the middle third and eventually this area will be enlarged enough to include the point of demand. If the former method is to be used, it is necessary to decide why the point of demand does not fall into the middle third. Is it because of the accommodative-convergence relationship? Is proximal-convergence the factor or is it accommodation? If the answer to these and other questions points to the more innate reflexes, hope of success, at least in the writer's opinion, is very poor. On the other hand, if the fault lies with the more acquired type of function, this attack might be successful. As an example of this line of reasoning one may consider the reduction of phorias and squint. Generally, the fusion free or phoria position is dependent on the more innate types of functions, while frequently a squint is acquired in order to avoid normal binocular vision. In all the orthoptic literature very few, if any, substantial changes in phoria are to be found but frequently squints totally disappear and the phoria remaining after successful squint training is most frequently less than the original angle of deviation in a squint. The methods used to increase the area of the zone of single binocular vision are more successful and much more easily applied.

Both of the general methods of attack mentioned above imply some change in the motility reflexes associated with binocular vision and some method of analysis of clinical data in order to find the basic error in the subject's attempt to compensate. In the last few years a great many papers have been published by Lange[18, 19] reporting on a method of using a long focal length Brewster type stereoscope with transilluminated targets. This stereoscope is called the "co-ordinator." Lange has proposed a very simple method of analysis and cook book recipe type of training for every type of anomaly. His reports on results indicate that every binocular anomaly yields to this method and ". . . as this development is continued, the refractive error becomes less and less if no glasses are worn." Since these claims were so startling it was decided to investigate all types of binocular training in which changes in motility was not the purpose or method. Thus a general investigation of the use of stereoscopic targets in orthoptics was undertaken at the School of Optometry, University of California. The investigation was financed by the American Academy of Optometry. This investigation was continued

for a little more than three school semesters. The method employed was to divide patients into balanced groups, as nearly as possible. Each group was given a specific course of training and the results were compared by statistical analysis, which resulted in many tables of figures. It is always difficult to make such a report interesting or even informative to the majority of readers. Nearly all of us skip hastily over tables of figures. An attempt will be made to reduce the number of these tables to a minimum.

For the sake of convenience all subjects were divided into seven general categories before subdividing into treatment groups. These seven categories were: amblyopia, strabismus, low positive relative convergence or high insufficiencies of non-fusional convergence, low negative relative convergence or too high non-fusional convergence, hyperphoria, low myopia, and cyclophoria. Nearly all the subjects, except for the strabismus cases, were college students referred by clinicians to the orthoptic clinic.

Since so many of the patients were trained on the co-ordinator, and since a great many optometrists are not familiar with this instrument a detailed description of the one used is included. The co-ordinator is a simple stereoscope in which the targets are transilluminated. The lenses are +2.25 D. spheres separated so that their optical axes are 79 mm. apart. The distance from the back surface of the lenses to the targets is 41.6 cms. or a dioptric distance of 2.40 D. Thus for all practical purposes the targets are in the focal plane of the lenses.

The targets are printed on paper and bound between two sheets of glass. A rather ingenious method of diffusing the target before the better eye in the amblyopic series of targets has been devised. The target is turned backward so that the printing must be seen through the paper. In the amblyopic series the flat targets have a separation between centers of 80 mm. Thus for practical purposes the visual axes must be held parallel for fusion.

In the Lange technique, binocular vision is maintained at all times in the treatment of all anomalies, including amblyopia. Repetition of stimulus is achieved by a flasher—15 seconds on and five seconds off. Several different series of targets are available: color fusion series, amblyopic series, fusion series, and stereoscopic series. In all cases the patient is shown the F L chart which has white letters on a black background. The letters have an 80 mm. separation. Then using the results of the patient's report of what he sees and whether or not he has amblyopia, the proper starting slide is chosen, and then each slide after

this one is used one after the other as the patient progresses. In each series the targets are large at first and become smaller through the series. There are slides requiring both central and peripheral fusion. The stereoscopic series require as a maximum some plus or minus 5△ of convergence.

AMBLYOPIA

There were eight subjects manifesting amblyopia not associated with strabismus. Of this number, five had anisometropia or antimetropia. In two cases the vision in the poor eye was less than 20/200. In the balance of the cases the vision ranged from 20/40 to 20/200. These subjects were divided into two groups of four each. Two criteria of division were used: all subjects with large pupils were placed in one group providing this did not make the two groups unbalanced as far as V.A., refractive error, etc., was concerned. The group with the larger pupils was trained following exactly the technique outlined by Lange with one exception. The other group was given the treatment most in vogue today; namely, best possible refractive correction, patching the better eye, and general binocular training.

The eight patients were divided into two groups as shown in Figure 2.

AMBLYOPIC SUBJECTS

Subject	Co-ordinator Group	Subject	General Group
G.R.	VA 20/20 and 20/300	M.A.*	20/20 and 20/400
S.B.*	VA 20/20 and 20/200	B.L.*	20/25 and 20/200
W.E.*	VA 20/30 and 20/200	J.B.*	20/30 and 20/200
G.D.	VA 20/20 and 20/60	I.M.	20/20 and 20/40

*Anisometropia or antimetropia.

Visual acuity with best correction of amblyopic subjects before training.

Figure 2

As mentioned above, there was one departure from the co-ordinator technique. This was in the case of subject W.E. who was given his proper lenses and told to wear them at all times. Except for this one subject none of the other three subjects treated on the co-ordinator was given lenses.

Motivation is the big problem in every case of amblyopia. Improvement, if any, is slow and gradual and unless the subject is constantly impressed with the necessity of concentrated effort, interest soon wanes and the results obtained are negligible.

As mentioned already, the control group received the best possible

correction and careful instruction in patching the better eye for the maximum possible each day. Also the subjects were instructed to use the poor eye. They were carefully coached and coaxed to "see" with this eye. The results are shown in Figure 3.

Co-ordinator					General				
Subject	Before		After		Subject	Before		After	
	VA	VE	VA	VE		VA	VE	VA	VE
G.R.	20/300	8%	20/200	20.0%	M.A.	20/400	4%	20/200	20.0%
S.B.	20/200	20%	20/50	76.5%	B.L.	20/200	20%	20/200	20.0%
W.E.	20/200	20%	20/80	58.5%	J.B.	20/200	20%	20/80	58.5%
G.D.	20/60	70%	20/50	76.5%	I.M.	20/40	84%	20/40	84.0%

Visual acuity and visual efficiency[20] in amblyopic eye before and after training 13 weeks. Lens giving maximum acuity before eye.

Figure 3

The data presented do not adequately describe or indicate the changes involved. All who have worked with visual problems are cognizant of the fact that the measurement of low visual acuities is subject to great variations. Subject B.L. put forth no effort at all to improve her condition. Subject S.B. who received no instruction about patching his better eye did so on his own volition at all times when not in the clinic or classroom. The fact that he used a patch was not discovered until he was questioned at the end of the semester just before being discharged for the term. Incidentally, this subject heard that carrot juice was good for poor vision. He did a little library research and discovered that if there was anything to the carrot juice stories, it was the vitamin A content. Consequently he took a minimum of 10,000 units of vitamin A daily. The writer does not believe that the vitamin A intake had much of anything to do with the improvement in this case. The important factor is that this subject was really interested in improving his condition. He did more than was required or asked—a rare type of individual.

The only changes in refractive error during the period was a slight increase in the myopia of subject M.A. and a slight increase in the subjective acceptance of convex lens power in subjects S.B. and I.M. The subjective findings more closely approximated the objective in these two subjects.

STRABISMUS

There were 21 subjects with strabismus treated during this experimental period. Some 15 had varying degrees of esotropia while six had exotropia. All had concomitant squint. Out of the 15 esotropes, nine

were in the age level from four years to 12 years. One of these youngsters was receiving post-operative training. Out of the six subjects with exotropia only one was below college age. Among the nine youngsters, three did not have, as nearly as could be measured, any degree of binocular vision. Eight of the esotropic subjects had anomalous correspondence while none of the exotropic ones did. Three of these with anomalous correspondence evidenced fair fusion and some degree of reserves at the anomalous angle. All subjects with anomalous correspondence passed easily the F L co-ordinator test and most of the Keystone D B series tests, and yet they were esotropic, one more than 30△.

These subjects were roughly divided into three equal groups. One group received training only on the co-ordinator, one group on the troposcope, and one group on all instruments such as the rotoscope, stereorthopter, tel-eye-trainer, myoculator, cheiroscope, Remy separator, Cantonnet stereoscope, co-ordinator, troposcope, and anything else that could be thought of to keep the training as interesting as possible.

The distribution of the cases among the various types of training is shown in Figure 4.

CO-ORDINATOR	TROPOSCOPE	GENERAL
2 Exotropia	2 Exotropia	2 Exotropia (1 alternator)
2 Esotropia with anomalous correspondence	3 Esotropia with anomalous correspondence	3 Esotropia with anomalous correspondence
2 Esotropia, normal correspondence	1 Esotropia with normal correspondence	1 Esotropia, normal correspondence
1 Esotropia, no binocular vision	1 Esotropia, no binocular vision	1 Esotropia, no binocular vision

Distribution of subjects as to type of training

Figure 4

While squint is an interesting study it is really not a part of this report on the use of stereoscopic targets in orthoptics. It is included because the writer believes too few men in practice are sufficiently careful to avoid the pitfalls in anomalous correspondence. As has already been mentioned above, some subjects with anomalous correspondence can successfully pass some of the crude tests for binocular vision. Apparent duction measurements may be made.

On the whole, the results were more successful than we had anticipated beforehand. There was one successful response in those subjects given training on the co-ordinator. One of the subjects with exotropia obtained single binocular vision after six training periods and maintained his visual lines in the straight position after eight periods. In

every other case treated by the co-ordinator technique anomalous correspondence was either established or reinforced. There were three successful responses on the troposcope: the two exotropic subjects and the esotropic subject without anomalous correspondence. There was one successful response to the general treatment: one of the exotropic subjects.

LOW POSITIVE RELATIVE CONVERGENCE

This is the "catch all" grouping. In this category there were somewhat over 200 subjects. In this group were placed those subjects manifesting either a low positive relative convergence or those manifesting a high insufficiency of non-fusional convergence or both. It is also the group that responds most readily to training of almost any nature.

For purposes of control an attempt again was made to divide and match these subjects into different sub-groupings for different training methods as shown in Figure 5.

Method	Number
Co-ordinator technique	37
Tel-Eye-Trainer	40
Rotoscope	41
Stereorthopter	38
Plus and base out	46

Figure 5

In using the co-ordinator the regular routine as recommended by Lange[18, 19] was followed. In general, this was true with respect to each instrument; that is, instructions furnished in the manual sent by the manufacturer with the instrument were used as intelligently as possible.

With the tel-eye-trainer auxiliary prisms were sometimes used while the targets were the ordinary stereograms of the Keystone View Company.

The logic of using convex lenses with base-out prisms can be derived as follows: When a person fixates at any finite distance a certain amount of convergence is stimulated which is not related to fusion. This convergence is mainly accommodative although some is due to the nearness concept and some to the tonicity of the muscles. Now if some accommodation is inhibited by using convex lenses to view the target, then accommodative-convergence is also reduced. This puts a greater load on fusional convergence. If base-out prisms are now added, the load on fusional convergence is further increased.

Of the five general methods employed, the last gives the quickest and most dramatic results. The two methods employing very little load on fusional convergence but placing the major emphasis on quality of

fusion; namely, the co-ordinator and the tel-eye-trainer were the slowest methods as far as measurable results were concerned. However, both of these methods gave rather prompt relief from subjective symptoms. This particular anomaly, as found in college students, is very amenable to training of almost any type.

OVER-CONVERGENCE

In this group were placed those subjects referred to orthoptics because of over-convergence or because of low negative relative convergence. There were only 30 of these subjects since most clinicians have found it far more satisfactory to prescribe lenses for near work to relieve the over-convergence by reducing the accommodative-convergence. Only those subjects were referred to orthoptics, as a rule, who did not get relief from reading lenses. As with the low positive reserve cases, these subjects were divided into five groups of six each.

The results on the whole were very poor as far as a decrease in over-convergence was concerned. Comfortable adaptation, however, was established eventually in all but five subjects.

HYPERPHORIA

Nine patients with hyperphoria were given training by orthoptics. Here again the number is low because most clinicians have found by experience that the prescribing of vertical prism is the simplest method. Contrary to what some have claimed, it has been the general experience in the University clinic that hyperphorias do not increase when the proper prism is prescribed.

These subjects were divided into three groups of three each. One group was given training on the co-ordinator, a second on the tel-eye-trainer, and a third on the phoropter with prism base, in the direction of deviation.

The results were poor both as to actual change in condition and as to comfort.

MYOPIA

There were 25 subjects sent to the orthoptic clinic because they were apparently just becoming myopic. These subjects were a carry-over from the time just previous to the three semesters of this report when some emphasis was placed on the reduction and control of myopia by orthoptic methods. We had undertaken the study of the reduction and control of myopia for two main reasons. First, the optometry clinic was swamped with V-12 trainees who had low degrees of myopia. They were extremely loud and insistent that some attempt, at least,

should be made to see to it that they would be able to obtain their commissions in the Navy upon graduation. Second, there was a great deal of underground rumor that myopia was being reduced in Baltimore and furthermore various traveling lecturers were insistent that myopia was being cured by progressive optometrists all over the country.

Ten of the subjects covered in this report received co-ordinator training while the balance were given all types of training. We made an honest attempt with every method that was reported to us by anyone. We also tried a few original methods of our own.

The results were entirely negative as far as the reduction of myopia was concerned. Most of the subjects were able to tolerate their blurred vision better after training but their myopia was not reduced to a measurable extent in a single instance. The refractive state was determined by skiametry, subjective to maximum acuity, and by haploscopic methods. On the whole, the subjective finding to a bare 20/20 was less and on the average, naked visual acuity was improved 1½ lines on a standard Snellen chart.

CYCLOPHORIA

Three subjects manifesting cyclophorias were given training. One subject who had only 5° of cyclophoria received training on the co-ordinator. The other two had diplopia at all times and could not fuse any targets unless one was rotated at least 10°. These two subjects received training on the troposcope.

In none of the three cases was there any improvement. A great deal more must be known about cyclophorias before really successful training can be undertaken. Normally considerable cyclo-fusional ability is present as has been proven by the investigations of Ogle[21] and Ellerbrock.[22] If the neurological basis is present for cyclo-fusion, non-success in training is probably due to improper approach and methods.

DISCUSSION

Before discussing at length the conclusions that can be reached after analysis of the results of this investigation, it will be well to point out a few simple things about a Brewster stereoscope that optometrists frequently overlook.

First of all, when the targets are in the focal plane of the lenses in the stereoscope, convergence required to fuse any stereogram is independent of interpupillary distance. Figure 6 illustrates this situation. All rays of light in the eye space are parallel to each other and consequently they all make the same angle with the midline.

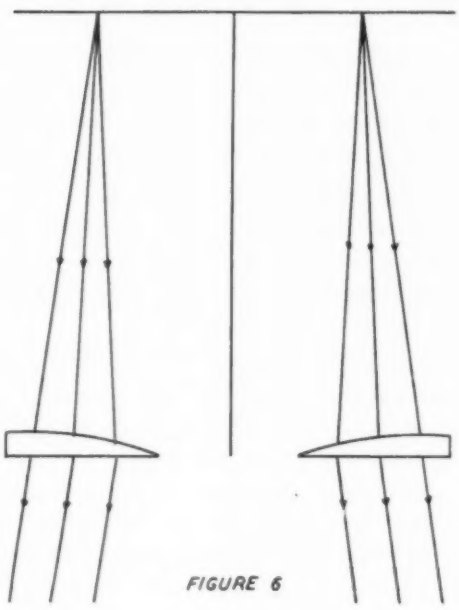


FIGURE 6

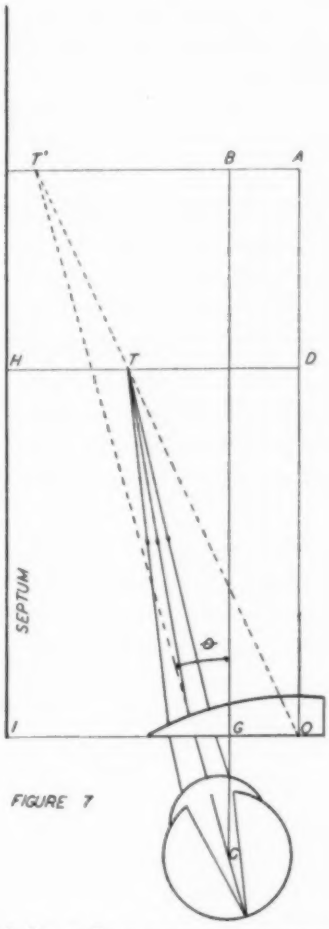


FIGURE 7

Another factor that must be considered in using any stereoscope is that as the stereogram approaches the eyes, relatively less convergence is required. From Figure 7

$$\tan \text{Ø} = \frac{T'B}{CB} = \frac{T'A - BA}{CG + GB} \quad (1)$$

$\triangle$ ODT aad OAT′ similar

$$\therefore \quad \frac{TD}{OD} = \frac{T'A}{OA} \text{ or } T'A = \frac{(TD)\ (OA)}{OD} \quad (2)$$

substitute in 1 above

$$\tan \text{Ø} = \frac{\frac{(TD)\ (OA)}{OD} - BA}{CG + OA} \quad (3)$$

A good average value for CG is 25 mm. and by multiplying both sides by 100, tangent measurements are converted to prism diopters.

$$\therefore \text{Ø (in } \triangle) = 100\frac{\left(\frac{(TD)\ (OA)}{OD} - BA\right)}{25 + OA} \qquad (4)$$

On any stereogram TD can be measured as can the distance OD. Distance OA must be calculated from simple paraxial refraction laws. Distance BA is the distance from the septum of the stereoscope to the optical center of the lenses minus one-half the interpupillary distance. An example will make the working of this formula clear.

In the telebinocular the separation between optical axes of the lenses approximates 94 mm. Assume a stereogram is in place which has a separation between two similar features of 78 mm. Suppose the subject has a PD of 64 mm.

When the target is in the focal plane of the +5.00D lenses, marked 0.00 D on the central bar of the telebinocular, the amount of convergence is obviously

$$\text{Ø} = 100 \left(\frac{TD}{OD}\right)$$

Therefore the convergence needed is

$$\text{Ø} = 100 \left(\frac{8}{200}\right) = 4\triangle \text{ for each eye or a total of } 8\triangle$$

Now assume the target is moved forward to the 1D mark on the scale, implying that 1D of accommodation is needed to see the target clearly; that is, distance OA is equivalent to 1.00 D or OA = 1000 mm.

Now the distance OD may be calculated from the paraxial law

$$\begin{aligned} U' &= U + F \\ \text{or } U &= U' - F \\ &= -1 - 5 \\ &= -6D \end{aligned}$$

$$\text{or OD} = \frac{1000}{6} = 166.7 \text{ mm.}$$

Substituting in equation 4 above, we have

$$\text{Ø} = 100\frac{\left[\frac{(8)\ (1000)}{167} - 17\right]}{25 + 1000}$$

$$= 100\left(\frac{48 - 17}{1025}\right)$$

$$= 3\triangle \text{ for each eye or a total of } 6\triangle \text{ for both}$$

Now since accommodation of 1.0 D will ordinarily stimulate some 4△ of accommodative-convergence and since proximal-convergence in a telebinocular approximates 8△, the similar parts of this stereogram now call for a relative divergent movement of the visual lines.

Thus in the use of stereograms in the stereoscope four factors must be kept in mind.

1. When the stereogram is in the focal plane of the lenses, convergence is independent of the subject's interpupillary distance.
2. When the stereograms are not in the focal plane of the lenses, convergence is not independent of the subject's interpupillary distance.
3. As the targets are moved toward the eyes, relatively less positive convergence is required.
4. Proximal-convergence is an important factor when using the stereoscope.

In analyzing the results of training the low positive relative convergence subjects on instruments such as the co-ordinator, where motility was not a factor in the training method, it was possible to divide the subjects into two groups. One group responded by showing a marked improvement in the fusional movements while in the other group fusional movements did not improve rapidly. This same apparent division into two groups was possible in the over-convergent cases.

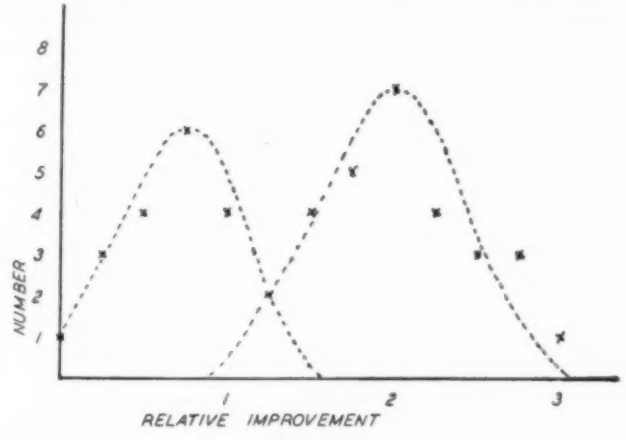


Figure 8

Where the treatment method involved motility, such as when prisms were used, the subjects could likewise be divided into two groups depending on the rate of response. This division was most pronounced

in those subjects receiving treatment using plus and base out and least noticeable in subjects receiving treatment on the stereorthopter. This division can be seen in Figure 8. The abscissa values are total improvement in motility divided by the number of treatments. Shown on this figure are two dotted curves which might theoretically explain this peculiar two-humped curve. For sake of simplicity, these might be termed group A and group B. The rate of response of group B being about twice that of A.

The records were then divided on the basis of these two theoretical curves. When these data were analyzed, it was found that group A exhibited, before training, what Giles[23] has termed binocular instability; that is, suppression or neutralization of different parts of a simple stereogram. This group also exhibited a lower degree of stereopsis.

The subjects given training on the co-ordinator exhibited the same division. The group which responded by increased motility exhibited five times more frequently binocular instability than did the group which did not respond by increased motility.

The logical deduction would be to give subjects who have binocular instability, training on some simple stereoscopic device as the co-ordinator, and those subjects not having binocular instability, training for motility.

With this idea in mind, an attempt was made to devise some simple tests which would enable one to divide patients into these two groups before training was undertaken. One of the first problems encountered was the question of where does retinal rivalry stop and suppression begin? Rate studies are too tedious and unreliable for clinical methods. After several attempts, it was deemed prudent to omit any attempt at differentiation other than calling it suppression when one section of any diagram remained rather constantly "hidden." On the other hand, if first one eye's view was seen and then the other alternately it was called rivalry. Various standard stereograms were used such as the F L chart of the co-ordinator series and of the Well's cards, and the F and G series of the Well's cards. Various Keystone cards of a similar nature were used. Also various cards designed to measure stereopsis were tried.

The various "suppression cards" were weeded out until only the F L card was used.

In addition to these standard cards, attempts were made to design a simple test for breadth of fusion. All the cards were quickly eliminated except two, which are illustrated in Figures 9 and 10.

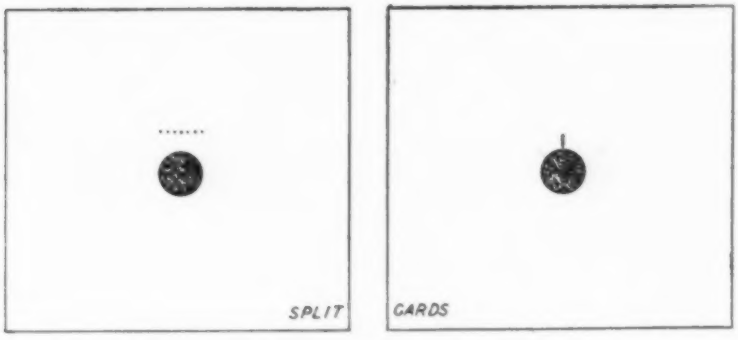


FIGURE 9

The target illustrated in Figure 10 is really similar to a measure of stereopsis. In using this card the subject fixes the small dot in the center. The outer circle has a diameter of 1 cm. Then at the position of best fusion the targets before the other eye which have circles in 1 mm. steps are presented. The largest and smallest circles fusing with the standard

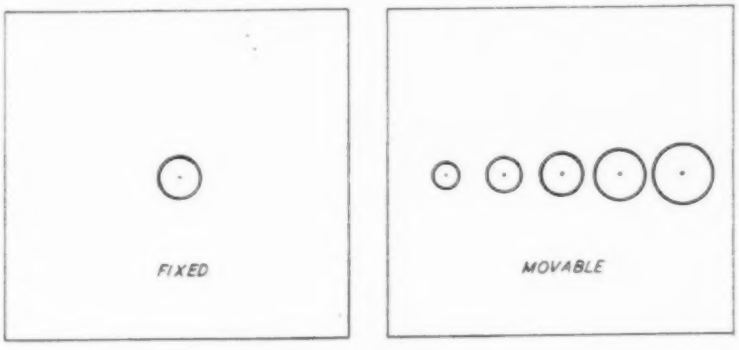


FIGURE 10

one are determined. The target illustrated in Figure 9 makes use of fixation disparity.[8] The split cards are moved until easiest fusion results. In this case, the subject sees a single ball. Above this is a dotted i. The cards are moved closer together and further apart until fusion is broken in either direction. As the cards move, the ball stays single but the i and its dot tend to move relative to each other so that successive dots on one side or the other become the dot for the i.

After checking these cards on patients, it was tentatively decided to classify patients as having binocular instability when they failed to successfully pass any one of the following tests:

1. When any part of the F or L when fused into an E disappeared.
2. When the subject failed to fuse a circle of 12 mm. or 8 mm. diameter with the 10 mm. one.
3. When the subject was unable to fuse with a fixation disparity of $\pm$ 1$\triangle$.

These checks were tried on some 25 additional subjects. Out of this group 10 were placed in the group of unstable binocular vision while 15 were placed in a group of stable binocular vision. Five of the 10 subjects with instability were given training on the telebinocular using just simple stereoscopic pictures while five were given the routine training on the co-ordinator. All 10 subjects began to show improvement in the relative convergence tests after the second training period.

These results seem to indicate that while motor responses are involved in binocular vision, seeing is not entirely motor. If we think of vision as being made up of three processes: sensory, integrative, and motor, each independent and dependent at the same time, we can safely assume that none of its three parts is safe from malfunction. If the sensory and integrative parts do not function properly, the motor response will of necessity be poor. Wald and Burian[24] found in amblyopia that form vision was reduced, but that the light sense was normal. They conclude in part, ". . . it is concluded that this disability consists in cortical inhibition of the higher cortical function of pattern vision without notable impairment of the lower cortical functions of light perception and spatial distortion." Thus in squint inhibition occurs in the integrative level of seeing. No one doubts that in suppression the image exists on the retina or that it is transmitted to the higher centers.

It would thus seem that in planning orthoptics the source of the difficulty must be determined. If the zone of single binocular vision is not sufficient to allow for comfortable vision, the probabilities are that it is due to motility but, on the other hand, it may be due to the integrative function. Fusion is characterized by quality as well as quantity. If the motility of the eye is poor because the motor function is poor, it is a waste of time to give training on simple stereograms or on the co-ordinator. If the motility of the eye is poor because either the sensory or the integrative function is poor, it is a waste of time to give training involving motility without first giving some sort of stereoscopic training.

One of the theories of squint commonly prevalent today is that the deviation of the eye is for the express purpose of avoiding binocular vision rather than that binocular vision is impossible because the eyes

deviate. Thus squint would, according to this theory, be the result when there is some interference in the sensory or integrative activities of vision. The possibility exists that squint results when these interferences exist during the anatomical and physiological development of the visual mechanism. If, on the other hand, the interference develops later, binocular instability results.

Refractive errors are anomalies that interfere in the sensory part of vision. Uncorrected errors of refraction stimulate a motor response (accommodation, squinting the lids, etc.) in order to sharpen the retinal image. Giving orthoptics to facilitate this motor response will undoubtedly enable it to be made more readily and may even temporarily cause the subject to appear to be adequately compensated, but the refractive error still exists. If after training, lenses are given removing the real cause of the difficulty, the subject should and does perform even more adequately. Unfortunately there is no possible motor response which can successfully compensate for such errors as myopia and astigmatism except squinting the lids. Astigmatic accommodation probably exists to a limited amount but it is not sufficient to compensate adequately for any amount of astigmatism.

A very serious attempt was made during this experiment to alter the accommodative-convergence relationship in a group of 15 subjects. There was absolutely no success in changing this relationship at all. Frequently the ACA ratio is confused with what is called the "near point phoria." While the size of the "near point phoria" is determined to a certain extent by the ACA ratio, the two are distinct entities and should not be confused with each other. The "near point phoria," as measured clinically, is affected by muscle tone, proximal-convergence, peripheral fusion, and the gadget by which the measurement is made to mention a few factors; while accommodative-convergence is not so affected.

Briefly and in conclusion, the results of the investigation indicate that orthoptic methods designed to change the reference point in the zone of single binocular vision fail to do this. Results are obtained by increasing the overall size of the zone. If the zone is small because the sensory mechanism is faulty, best results are obtained by lenses. If the zone is small because the integrative mechanism is faulty, best results are obtained by training on simple fusion and stereoscopic devices. If the zone is small because the motor mechanism is faulty, best results are obtained by training on devices increasing motility.

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SQUINT—THE PSYCHO-PHYSIOLOGICAL ASPECTS INVOLVED IN ITS TREATMENT*

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The correct diagnosis, treatment and cure of squint, today, opens one of the greatest fields for investigation in the profession of optometry. Heretofore, many of us have been guilty of placing a squint case in a cumbersome piece of apparatus, without regard for, or understanding of the psychological changes that have taken place in the visual behavior patterns relative to spatial relationships. Then we have applied either a base-in or base-out prism in an attempt to straighten eyes that deviate from a condition of parallelism. Our present-day techniques take into consideration the psychological aspects of how the squinter sees and attempts to reorganize visual patterning to enable him to overcome his handicap.

Generally, under normal conditions, we assume that shortly after birth there is developed an awareness of physiological diplopia. This awareness of diplopia eventually creates a strong desire for single binocular vision. As the individual grows older up until the first year of life, the retention of single binocular vision increases in strength and with that comes an awareness as well as an increase in stereoscopic acuity. Thus we have our start of normal binocular vision.

From an etiological standpoint, we have as the basic causes of squint, a consideration of the following factors:

1. *Accommodative.* A difficulty in rate of learning to fuse and/or a difference in physiological development combined with an inability to overcome a fairly large degree of ametropia and at the same time maintain normal functioning of the accommodative-convergence relationships may result in a sharp cleavage in accommodative convergence visual patterning ending in squint.

2. *Trauma.* Either of psychological or neurological nature in which the cause is neither anatomical nor functional, but rather a sharp break in visual patterning against a given set of conditions that apparently seem to be in conflict with the organisms well-being.

3. *Febrile diseases.* Producing a general weakening of anatomical

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structure and therefore resulting in an inability to maintain normal functioning.

4. (a) *Injuries sustained at birth.* Injury to any specific part of the visual area of the brain with the formation of a brain lesion and a resulting degeneration of nerve fibers back to the retina to produce a central scotoma.

(b) *Injuries resulting in the impairment of neurological or myological functioning.*

5. *Hereditary squints.* Familial squints that can be traced from generation to generation.

In general, squints fall into two broad classifications, paralytic and non-paralytic. The paralytic squint shall be discussed elsewhere in another paper. Of the non-paralytic type of squint we have (a) the monocular squint, and (b) the alternating squint. In the monocular squint, we generally find among high ametropic conditions, a marked lowering and difference of acuity between the eyes. We assume then either one of two possible factors as being responsible, (a) a central scotoma which may be demonstrable, or (b) an amblyopia. In either case, the eye will turn sufficiently so as to expedite the acquiring of suppression habits in order to eliminate visual confusion as a result of diplopia.

In the alternating type of squint, we have the ultimum in visual conditioning in order to overcome existing visual handicaps. Acuity is generally equal in both eyes, and either eye may be the fixating eye at will depending upon the location of the fixated object. As the object moves into the adjacent field of view, the previously non-fixating eye now assumes the burden of fixation. In the alternating squinter we have binocular vision; but a binocularity composed of two separate entities in that the squinter can justify and reconcile the distinct and separate imagery as seen by either eye. No mental conflict arises to confuse the individual. He may fixate with one eye and be perfectly aware of what transpires in the field of the non-fixating eye. It is in this particular type of case that suppression areas may be built up in the brain from stimuli arising in and around the macula to act as a further block in order to prevent the attainment of single binocular vision. It is in the alternating type of squinter that we meet one of the most difficult problems necessary to be overcome, namely, horror fusionalis, or macular aversion to fusion, which will be discussed later.

Whatever the cause of squint, we assume that from the outset a state or condition of diplopia exists. It would seem from the evidence

that in the early stages of squint that normal projection is of fairly common occurrence. As time passes, the individual may find it difficult to reconcile himself with his surroundings because of his similar diplopic state (consciousness of similar imagery) so that simply as a self-defense mechanism he deliberately (a) learns to suppress the image seen by the deviating eye or (b) pays no conscious regard to the second image as seen by the deviating eye and rather prefers to reconcile the broad vista seen by the deviating eye with the object as seen by the fixating eye. Such a condition is more commonly known as anomalous projection.

When the condition of anomalous projection does set in, then the eyes make a compensatory turn in relation to each other so that the apparent angle of squint may appear to be lessened. As a definition, then, of anomalous projection, we may promulgate the following: Anomalous projection is that condition wherein the objective angle of squint is not in accord with the subjective angle of squint; and further, that the lateral separation of similar diplopic imagery is not commensurate with the true angle of squint as measured at a specific distance; and still further, that the spatial projection of imagery is maintained along muscle sense direction rather than projection along true physiological lines.

The concept of single binocular vision is based upon the fact that the images of points which are identical with each other in the visual fields must fall upon identical or corresponding points in the retinae of both eyes. When the two images of an object fall upon these points, then, and then only is single binocular vision possible. If the two images of an object do not fall upon corresponding points then diplopia ensues.

The very basis then, for the correction of squint and the future conditioning of the patient is dependent upon providing sensations on corresponding points of the two retinae in order to stimulate that innate function, single binocular vision, to take hold again. Since we appear to start life with diplopia and acquire the sense of single binocular vision, it would seem, therefore, that normal retinal correspondence is not an anatomical but rather a functional attribute that is capable of development.

The development of normal retinal correspondence or the breaking down of anomalous projection habits in the squinter is based upon the fact that he must be taught true spatial projection and localization of objects in space. Modern day psychological approaches advocate the importance of the interrelation of the senses other than that of vision as an aid in the breaking down of anomalous projection habits. The kinesthetic sense has long been used in optometric routines and

procedures, such as the hand and eye techniques. It seems that psychological contentions are, that the localization of objects in space is related to and is dependent upon the position of the head and trunk as pivotal centers with respect to the surrounding world, and that the adjunct senses of touch and hearing are of primary importance as a reinforcement aid for proper spatial localization.

In breaking down anomalous projection, the squinter must be shown exactly where to perceive similar diplopic imagery. A constant struggle is then evident between the acquiring of a new pattern of seeing as against the defensivistic method of seeing already acquired. This struggle is maintained throughout the duration of treatment, since from the squinter's standpoint, everything that he is going to learn now about seeing along the lines or principles of true physiologic optics is going to conflict with his factual mode of seeing.

Fundamentally, the squinter must first experience the binocular concept of luster in the initial phase of training. This sensation may be induced either with or without stereoscopic equipment. However, we do not advocate the use of such equipment during the initial phases of treatment because the squinter psychologically will not and rarely does carry over that which he sees in an instrument into the outside surrounding world.

With the attainment of the phenomenon of luster, we can then proceed to teach the squinter true spatial projection, or awaken the sense of true physiological diplopia. Knowledge and understanding on the part of the examiner as to the true and proper spatial relationships of diplopic imagery is an extremely important factor as it is the duty of the examiner to try and open the so-called mental door in the brain of the squinter in order that the squinter may project accurately with either eye as the fixating eye and still maintain physiological diplopia.

This sense of physiological diplopia must be built up for all distances ranging from the near point to infinity. As an additional adjunct or aid, strong convex or concave lenses may be utilized to facilitate such an attainment. The realization of physiological diplopia serves to establish an important fact—that somewhere between infinity and the patient there must be a point where the visual axes or lines of fixations of either eye must cross or intersect. The establishment of such a point is not difficult to achieve or demonstrate using the simplest of equipment such as a pair of red-green filters and an ordinary ophthalmoscope light bulb.

The establishment of a crossing point of the visual axes then gives us a point in a plane within which all objects presumably should be held single. This invariably seems to hold true except in those cases

where there seems to be a strong macular aversion to fusion. It would then appear that when bi-macular attention is required that there is a buckling in the horopter plane at the crossing point of the visual axes and single binocular vision would then be unattainable. This would hold true if we permitted direct bifoveal excitation. However, we find that during the early phase of training, after physiological diplopia has been developed, that it is often possible to obtain gross fusion, stereopsis and depth perception by stimulating the peri-macular areas of the retinae. As the sense of fusion and stereopsis is strongly developed at all distances with gross targets, we can then begin to approximate the bi-macular areas in an effort to develop a finer sense of fusion and stereopsis, such as only can be had when both foveae are used.

The development of fusion and stereopsis in the extra-macular parts of the retina can best be attained by the employment of the Brock near-point and distance stereo charts with which red-green filters must be utilized. Many cases of squint not only have been, but can be, re-educated to a fair degree of normalcy by means of this simple equipment. At this period the patient can be introduced to more cumbersome pieces of apparatus which measure with a fair degree of accuracy the changes which take place in fusion range and ability as well as stereoscopic capabilities.

CONCLUSION

In conclusion, we may state that:

1. The acquiring of anomalous projection is but a defensivistic mechanism by means of which the squinter can reconcile himself with his surroundings.

2. That anomalous projection must be replaced by normal projection habits before any visual training program may be instituted.

3. Results achieved in the employment of cumbersome pieces of orthoptic equipment are rarely, if ever, carried over into the outside world during early phases of training, and finally,

4. Macular aversion to fusion can only be overcome by initially training with large gross stereoscopic targets and then, gradually approximating the foveal areas.

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HIGH EXOPHORIA AT NEAR POINT—A CASE REPORT*

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I. CASE HISTORY

OCULAR HISTORY

Mrs. H. M., 34, came to the office on February 5, 1947, to fill an appointment for a visual examination. The following information was obtained from the patient in taking the case history.

The patient reports that for some time she has had recurring styes. Her eyes have been bothering her for an indefinite number of years. She has had local treatment by her family physician for the hordeola but has never had a visual examination.

HEALTH HISTORY

The patient is in excellent health. She is the mother of two children. One child is eight years old, the other five. The patient states that she has had no serious illness in the past and was recently examined by her physician and found to be satisfactory. She states that her teeth are in excellent condition.

FAMILY HISTORY

The family history reveals no pertinent information. The patient's parents are farmers. There is no evidence of ocular disturbances on either side of the family.

SCHOOL HISTORY

The patient attended grammar and high school in the local school system (county). She states that she had some difficulty with her school work but that she managed to get through her studies. The condition did not seem to bother her as much then as at present.

OCCUPATION

The patient is a housewife. She is not employed on a job but devotes her entire time to her home and family.

SOCIAL AND RECREATIONAL HISTORY

The patient leads the social life common to a small rural town. Her main recreation is calling on friends. She states that she does little or no reading at present.

COMPLAINT

The patient complains of severe asthenopic symptoms. She says:

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"I have a great deal of difficulty when I try to read for any length of time. When I try to, the front of my head right above my eyes hurts. I am no longer able to read and always come out of a movie with a headache. I have been bothered with styes on my lids."

II. PRELIMINARY FINDINGS

EXTERNAL EXAMINATION

External examination of the patient's lids shows the results of the recurrent styes. There is a slight blepharitis marginalis, the edges of the lids being injected and some of the lashes missing. The puncta are clean and evidently open. The tarsal conjunctiva is slightly injected.

The bulbar conjunctiva and sclera are clear. The tissues are smooth and the vessels are normal in size and course. The cornea is not involved in any pathological condition and shows no evidence of previous disturbance.

The iris has even pigmentation and the edge of the pupil is smooth. The pupil is round and there are no adhesions.

PUPILLARY REACTION

The pupillary reaction, both direct and consensual, is normal. The reaction associated with accommodation and convergence is also normal.

ROTATIONS AND VERSIONS

The two eyes move synergicly in all directions. There is no evidence of restriction of movement when rotating monocularly or binocularly. The near point of convergence is approximately 30 centimeters, the left eye diverging from the fusion position at this distance. The cover test shows a slight exophoria at six meters with a high exophoria at near. The condition is not one of periodic strabismus but it is obvious that much effort must be exerted for clear single binocular vision at near.

The acuity finding at six meters is O.D. 20/20, O.S. 20/20 and O.U. 20/15, unaided. There is no previous correction.

III. OPHTHALMOSCOPIC AND OTHER TESTS FOR PATHOLOGY

RIGHT EYE

The cornea is seen to be clear of all anomalies. The anterior and posterior chambers are apparently of normal depth and the aqueous is free of any opacities. The lens is clear and shows no evidence of opaqueness. The position of the lens is correct. The iris surface is smooth in texture and pigmentation. The edges of the pupil are even. There is no evidence of adhesions. The vitreous is free of indications of fluidity and opacities.

The fundus picture is one of general health. The disc is sharply

defined and has its characteristic light pinkish color. There is a small deposit of pigment along the temporal edge. There is a moderate physiological cupping.

The vessels are normal with the arteries slightly smaller than the veins, a ratio of approximately four to five. The vessels branch obtusely and there is no evidence of tortuosity. The veins show no signs of indentation where crossed by the arteries. There are no hemorrhages or areas of anemia.

The fundus ground proper is of the healthy brick red color. There are no pigment deposits, exudates or discernible anomalies. The macula region is clear and the foveal reflex bright. As elsewhere, there is no sign of degeneration.

LEFT EYE

The ophthalmoscopic examination of the left eye reveals a similar picture of ocular health. The cornea surface is smooth and the stroma clear. The anterior and posterior chambers are normal in depth and the aqueous free of any particles. The iris surface texture is smooth and evenly pigmented. The pupil is round, its edges smooth; the lens is normal. As in the right eye the vitreous is clear.

The fundus ground has a healthy brick red color. The vessels are healthy and in proper size ratio. There is no tortuosity or venous indentation. A preretinal artery is seen on the temporal side of the disc. The disc itself has its light pinkish color and sharply defined edges. A comparable amount of physiological cupping is present.

OTHER TESTS FOR PATHOLOGY

(1) The confrontation test shows no marked constriction of the field in any meridian.

(2) The palpation test indicates no abnormality of intra-ocular pressure.

(3) Transillumination reveals no malignant condition.

IV. ANALYTICAL EXAMINATION

The following clinical findings were taken on this patient:

1. Ophthalmometer

O.D. 43.75 at 180 44.50 at 90

O.S. 43.75 at 180 44.50 at 90

By Javal's Rule approximate total astigmatism

O.D. — .25 axis 180

O.S. — .25 axis 180

2. Static Retinoscope (Net)

O.D. +0.50 —0.25 axis 180

O.S. +1.00 —0.25 axis 180

3. Cross cylinder and astigmatic dial for astigmatism
   O.D. None
   O.S. —0.25 axis 180
4. Monocular subjective
   O.D. +0.50 Sphere V.A. = 20/20.
   O.S. +50 —0.25 axis 180 V.A. = 20/20.
5. Binocular Subjective
   O.D. +0.50 Sphere
   O.S. +0.75 —0.25 axis 180 V.A. = 20/15.
6. Phorias and ductions at six meters
   Phoria 3 prism diopters exophoria
   Base-out ductions 8/16/4
   Base-in ductions 9/4

Acuity at 40 centimeters through subjective
   O.D. 20/20 O.S. 20/20 O.U. 20/25

7. Phoria and ductions at 40 centimeters
   Phoria 18 prism diopters exophoria
   Base-out ductions 6/16/2
   Base-in ductions 16/24/8
8. Binocular plus lens to blur +0.50 Sphere
9. Binocular minus lens to blur —1.50 D.

Fusion exists at near. There is no suppression and no manifest strabismus.

V. ANALYSIS OF FINDINGS AND PROCEDURE

It is quite evident from the findings that the source of the patient's discomfort is, in all probability, the muscular (binocular) imbalance at near. It is true that there is a refractive error present but this error is of such a small magnitude that it most likely is of minor significance in this specific case.

The true importance of the relationship between the phoria and duction values in this case can best be demonstrated by use of the graphical method of analysis. The phoria and duction values for six meters and 40 centimeters were plotted. The criteria of Sheard and Percival, which are essentially the same, that comfort is more likely to exist if two-thirds of the duction is left in reserve at the point of demand (reserve equals twice the demand), are used as standard. It is obvious in this case that this criterion is not even approached. As a matter of fact, the phoria at near falls out of the range of clear single binocular vision. This explains the poor acuity at near as the patient

is probably accommodating in an attempt to produce convergence. However, the accommodative-convergence-accommodation (ACA) ratio is almost zero.

Inasmuch as the patient lives in a small town 25 miles distant served only by an unpaved rural road, it is almost necessary to attempt to alleviate the difficulty with the minimum number of office visits. By use of base-in prismatic power at near we can better the duction reserve-demand ratio by effectively changing the point of demand. The base-in prism will also reduce the blur at near.

This procedure was adopted and the final prescription was written as follows:

O.D. +0.50 D. sph ⌒ 2½△ base-in.
O.S. +0.50 D. sph ⌒ +0.25 D. cyl.
axis 90 ⌒ 2½△ base-in.

Correction for near only.

The patient was also instructed to attempt to build up the positive fusional convergence reserve by near point convergence practice at home. An orthor fusor was procured for the patient and she was instructed in its use.

A progress report one month later indicates that the patient has been relieved almost entirely of the symptoms. She reports an ability to read with much more comfort. She complains of the difficulty of the near point convergence exercise. Explanation of the necessity of this was given and she agreed to continue for another month.

At the time of the second check, the patient reported continued comfort with the correction. The near point of convergence has increased to 20 centimeters without the correction. The patient was instructed to continue the exercises and use of the training device. She is to return for re-examination in another six months.

SUMMARY

The patient is a housewife, 34 years old, who complains of severe discomfort resulting from any continuous near visual task. This condition has existed for an indefinite number of years and as a result the patient has ceased to do any reading. Subsequent examination and analysis showed the symptoms to be the result of a high exophoric condition at near with low compensating ductions. Since the patient resides in a small town 25 miles distant, office visual training is impractical. Prism, base-in for near only, supplemented by a home training procedure, resulted in elimination of the complaint.

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THE EXTRA-OCULAR MUSCLES—THEIR FUNCTIONAL REQUIREMENTS AND NERVOUS CONTROL*

Gilda Coppola†
Philadelphia, Pennsylvania

The importance of the extra-ocular muscles in helping to render vision useful and comfortable may be appreciated by a consideration of the numerous requirements which they must fulfill. The answer to their great versatility lies for the most part in the complex types of innervational control that these muscles receive. We shall endeavor to discuss some of the functional attributes of the extra-ocular muscles and attempt to show how they are actually manifestations of the neural control.

The primary essential in the interest of single binocular vision is that the extra-ocular muscles move the two eyes so that the object of regard stimulates corresponding retinal points of the two eyes. These movements comprise the fusional movements, and the adequate stimulus to elicit them is an object imaged on disparate retinal areas which attracts attention. The impulses which produce them originate from the occipital cortex from the area adjacent to the visual sensory and psychic areas. These movements are independent of the will and would in this aspect conform in type to reflexes, however, because interest, therefore consciousness, must be present, they are not considered true reflexes but are referred to as psychoöptic reflexes.

That it is possible for the object of regard to stimulate corresponding retinal areas for the countless fixations of the eyes is due largely to the fact that certain muscles of the two eyes are linked or conjugated in their movements. This linkage is made possible by a neural mechanism which insures that when a given muscle or muscles contract and produce some ocular movement the corresponding muscles of the other eye are activated to produce a proportional movement. This is stated in Hering's law as follows: innervation to the muscle or muscles of one eye is always accompanied by an equal and simultaneous innervation to the conjugate muscles of the other eye.

Conjugate muscles for movements where the visual axes remain

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parallel are as follows: the internal rectus of one eye with the external rectus of the other eye for lateral gaze, the superior recti and the inferior obliques of the two eyes for upward gaze, and the inferior recti and superior obliques of the two eyes for downward gaze. Muscles are also conjugated for non-parallel movements so that the internal recti of the two eyes are conjugated for convergence and the external recti for divergence.

Movements for fixation of distant objects are practically parallel and equal for the two eyes since the images of these objects are formed on corresponding areas. But in near vision most objects are imaged on disparate, non-corresponding areas and the movements required are non-parallel sometimes unequal and even unilateral. Unequal and unilateral movements are necessary when the object of regard lies closer to or along the visual line of one eye. The fact that fusional movements may be unequal and even unilateral does not contradict Hering's fundamental law of ocular movements. The apparent movement of a single eye is not produced by a unilateral innervational impulse. Let us take as an example the case where the fixated point lies at some close distance along the visual line of the right eye. Two impulses are conveyed to each eye, one for symmetrical convergence and the other for turning the two eyes to the right. Considering the two eyes separately, we find that in the right eye the two impulses direct the eyes in opposite directions and neutralizing each other, produce no visible movement. On the other hand, in the left eye both impulses direct the eye to the right and reinforcing each other, produce a visible movement to the right. The important fact remains that each eye has received an equal amount of innervation in spite of the fact that it produced different overt movements.

As a second requirement, the extra-ocular muscles must transport peripheral retinal images, which attract attention, quickly and accurately to the areas of greatest acuity, the maculae. Since the visual acuity of the retina falls off sharply outside the central area, a 50 per cent decrease 2.5 degrees off the macula, it is of the utmost importance that the macula receives the image of the objects which elicit interest. When an image falls upon the peripheral part of the retina and is appreciated by consciousness, the eyes are reflexly moved so that the image falls on the foveae. The impulses which promote these movements also arise from the occipital cortex similar to the area for fusional movements. The automatic character and the necessary mediation of consciousness also makes these movements psychoöptic reflexes: The pursuit of a

moving object is also mediated by this mechanism and it is referred to as the fixation reflex.

The extra-ocular muscles must be and are endowed with the ability to move the eyeball for prolonged periods without the fatigue associated with other skeletal muscular activity. Incongruously, these muscles consist of striated muscle fibers which physiologically are found to fatigue faster than the other two types of muscular tissue, that is, smooth and cardiac muscle tissue. What is then the explanation for these contradictory characteristics? The answer lies in the great strength of the extra-ocular muscles and the type of innervation they receive. It has been found that each of the extra-ocular muscles has the power to move a weight of 750 to 1000 gms provided all the fibers contract at once. The pull required to rotate the eyeball at its observed velocity is only 1 to 1¾ gms and 5 gms when making liberal allowance for the attached adnexa. This means that each extra-ocular muscle is powerful enough to exert a pull at least 100 times greater than the amount needed to move the eye. Thus less than perhaps one per cent of the fibers are made to contract at any one time and before the first set becomes fatigued the task is shifted to a different set and so on. By the time the first group is required to contract again they have had ample time to recuperate.

It must be emphasized that the ability of a small number of fibers of the extra-ocular muscle to contract is again possible by virtue of their innervation. Each of the muscle fibers has its individual nerve fiber supply unlike other muscles of the body where a great number of fibers are innervated by one nerve fiber and will contract as a unit. This enables each muscle fiber to act independently and a number as small as required can be called to contract at any given time.

An important practical application of the great margin of strength is found in cases of a partial paralysis of an ocular muscle. A muscle may be partially paralyzed and yet when the individual is required to follow a target, in many cases no limitation of movement can be detected in the direction of the deficient muscle. This is true only because a small fraction of the whole power of the muscle is used to move the eye and by exerting a greater effort the affected muscle is still able to move the eye to its limit. Only by watching the two eyes perform the particular movement together can a partial paralysis be determined. Since the innervation is never to one eye alone but always to both and always equal, the effort required to move the paretic eye moves the other too far and too fast. This method of watching the two eyes per-

form together is not always satisfactory, particularly where the vertical muscles are concerned. One of the best clinical methods for determining partial paralysis is the taking of motor fields which shall be described in a later paper.

Contractions of the extra-oculars must be graded so that delicate movements as well as wide excursions must be possible. Skeletal or striated muscles are capable of executing graded contractions because the individual fibers and not the whole muscle obey the all or none law. Only a few fibers of the motor nerve may be discharging impulses to their muscle fibers and produce a very limited contraction of the whole muscle, or more fibers may be innervated resulting in a much greater contraction. The number of graduations in the contraction of a muscle depends directly on the number of motor units, a motor unit being a nerve fiber and the muscle fibers it innervates. This unit obeys the all or none law. It can be readily appreciated that the greater the number of motor units the greater the variations possible in the strength of contractions. Thus if a muscle has 500 motor units there are theoretically 500 different contractions possible, each differing in strength. The extra-ocular muscles are greatly favored in this respect since each muscle fiber has its individual nerve supply, and there are therefore as many motor units as there are muscle fibers. This arrangement is vital in producing delicate movements for only when the motor unit includes a few or one muscle fiber can they be possible. The value of this system becomes apparent in transferring the gaze from one letter of very small print to the next. The importance is further emphasized in realizing that 99 per cent of the ocular excursions are small, less than 15 degrees from the primary position.

Smoothness of ocular movements is another essential and is promoted by the allied phenomena of reciprocal innervation and synergic control. Reciprocal innervation insures that the contraction of each muscle is accompanied by a simultaneous and proportional relaxation of its antagonist. Synergic control is a closely allied phenomenon and also functions in the interest of smooth muscular action. Synergic control manifests itself by allowing both the contracting or agonistic muscle and its antagonist to work simultaneously. The agonistic and antagonistic muscles are, therefore, to be considered as elements of a synergic group. The agonistic muscle represents the dominant element and it determines the direction of movement; while the antagonistic muscle acts as a cooperating check element determining the degree and rate of contraction and prevents excessive or jerky movements. Correlating these

two phenomenon, it would seem that at the onset of a contraction the antagonistic is innervated almost to an equal degree as the agonistic muscle and this innervation is gradually decreased allowing the contraction of the agonistic muscle to become smoothly visible. For example: If the internal rectus muscle were to contract its antagonist, the external rectus muscle would also at the onset receive innervation probably equal to the internal rectus. The external rectus innervation would then gradually decrease, permitting the action of the internal rectus to become evident. Thus the internal rectus, the agonistic muscle, determines the direction of contraction while the external rectus, the antagonistic, determines the degree and rate of the contraction.

Speed is another attribute of ocular movements and is facilitated by voluntary control over the extra-ocular muscles. The speed of voluntary movements is very high, varying somewhat with the direction—horizontal being most rapid and vertical the slowest. The center for the control of voluntary movements is localized in the posterior portion of the middle frontal gyrus. Another factor which is also important in promoting quick response from the ocular muscles is the great amount of tonic innervation which these muscles constantly receive and which keeps them in readiness for active contraction.

Another requisite is that the movements of the eyes must be correlated with movements of the head and body so that the movements of all these are in harmony with each other and have a common purpose. Changes in the position of the head and body are correlated with ocular activity by a number of reflexes. The vestibular nerve, one of the two divisions of the eighth cranial nerve, receives and conducts impulses from the semicircular canals, the sacculus, and utriculus of the labyrinth of the inner ear which registers the static and dynamic positions chiefly of the head and secondarily of the body. These impulses are relayed to Deiter's nucleus of the medulla and from here to the midbrain nuclei (lower centers) for the ocular muscles so that each labyrinth is in communication with the ocular muscles of the same side.

If the body or head moves to the left, the eyes compensate by moving slowly to the right; this is followed by a rapid movement to the left. These movements are not only horizontal, but may be vertical or rotatory in nature, depending on the direction in which the body or head is moved. These movements are compensatory and always occur in the direction opposite to the inclination of head. However, it has been found that an animal deprived of the semicircular canals and with its eyes closed or even blinded still performs these compensatory move-

ments. It can therefore be concluded that an additional source for these impulses exists. This source has been found to be the muscles of the neck. Stretching of these muscles and their tendons on changing the position of the head discharges impulses which are known as proprioceptive impulses. These impulses are relayed along the sensory nerves from these muscles to the spinal cord and finally an association is established with the nuclei of the third, fourth, and sixth nerves, resulting in appropriate movements. The purpose of these compensatory movements is to preserve as much as possible the correct orientation of the animal to the visual field.

The functional requirements and attributes of the extra-oculars which have been discussed are just some of the more important ones which time will allow me to review.

Since in the course of our descriptions we referred to the various parts of brain and the control they exert over the activity of the extra-ocular muscles, it may be opportune to review some of these neural associations.

The extra-ocular muscles receive their motor nerve supply via the third or oculomotor, the fourth or trochlear, and the sixth or abducens cranial nerves. These nerves consist of fibers which are processes or extensions of cells within the brain. The cells which give rise to the fibers of the third and fourth cranial nerves are located in the midbrain; those for the sixth nerve in the pons. Cell aggregates of this type within the central nervous system are known as nuclei. The neuron cell bodies making up these nuclei present a definite localization particularly in the case of the third nerve nucleus. The cells of the third nerve nucleus are arranged in fairly circumscribed subnuclei which innervate definite muscles. Thus we find that the following subnuclei make up each third nerve nucleus; a subnucleus for the levator, one for superior rectus, one for the inferior oblique, one for the internal rectus, and one for inferior rectus. In addition to these subnuclei for the extra-ocular muscles there is another for the intra-ocular muscles—the Edinger-Westphal nucleus for the ciliary muscle and sphincter of the pupil. There is one other subnucleus, the central, unpaired nucleus of Perlia. This is believed to be the lower center for convergence. The internal rectus muscle therefore is doubly represented in a subnucleus which is believed to control the muscle in lateral gaze and in the nucleus of Perlia, when the muscle is used in convergence. It follows therefore, that the internal rectus muscle might be impaired for convergence without being affected for lateral gaze or vice versa if one subnucleus were affected without the other.

The nerve cells of the nuclei perform very important functions by exerting a complex and unexplainable control over the extra-ocular muscles. The health, the normal activity and their continued maintenance as contractile tissue depend on these cells. When skeletal muscle is deprived of this fundamental control it ceases to live as muscular tissue and tends to revert to the simpler connective tissue and muscular atrophy and degeneration result. Tilney and Riley refer to this control as idiodynamic control.

The importance of the nuclei can be further stressed by considering that these neurons are the only link between the central nervous system and the muscles. This means that every impulse regardless of its origin within the central nervous system must always pass through this only bridge to reach the muscle. In view of these anatomical and functional relationships, these neurons have been designated by Sherrington as the final common pathway.

Many parts of the central nervous system exert their control over the extra-ocular muscles through this final common pathway. Many of these associations with the nuclei are complex and obscure and we shall mention only a few. The motor cortex is associated with the nuclei and enables us to have voluntary control over ocular activity. The area which represents ocular movements in the cortex is the posterior portion of the middle frontal gyrus.

The occipital cortex also sends fibers to the nuclei which synapse with the cells of the nuclei and through this path pass the impulses which result in the psychoöptic reflexes. The occipital cortex as we learned earlier is the area which receives the visual fibers. Extra-macular images and images which are focused on disparate retinal areas are appreciated at this level. If they elicit interest, motor responses flow to the nuclei which result in the fixation reflex in order to get a macular image or in fusional movements to obtain images on corresponding points or single binocular vision.

The cerebellum also exerts its influence over the ocular motility. The cerebellum is considered a motor organ. However, it does not send motor impulses for the initiation of movements but acts through various other centers playing an important role in regulation of muscular tone and in production of motor synergy. Motor synergy implies that any given movement is smooth, direct and precise. In any voluntary movement, the cerebellum regulates the entire motor pattern while the cerebral motor cortex controls its purpose.

The fibers which convey these impulses from the cerebellum are

collected in the superior cerebellar peduncle. These terminate and synapse with the cells of the red nucleus, and the latter give rise to fibers which distribute themselves and synapse with the cells of the final common path. This relay enables the cerebellum to exercise its control of the extra-ocular muscles.

The vestibular nucleus of Deiter which receives impulses from the labyrinth also is associated, as we learned earlier, with the nuclei and accomplishes the correlation of head and eye movements. The spinal cord centers for the proprioceptive impulses from the muscles of the neck are neurally connected with the nuclei and serve as complements to this mechanism of head and eye movement correlation.

The superior olivary body which is a nuclear mass associated with the auditory path establishes an association with the extra-ocular nuclei promoting reflex correlation of sound and eye movements.

There are many other central associations with the nuclei each contributing its control and promoting the integration of the eyes with other parts of the body. The full appreciation of the complex innervation of the extra-ocular muscles is beyond the scope of this paper; nevertheless, it is hoped that the idea has been conveyed that each of the functional attributes of the extra-ocular muscles is actually the expression of some neural center through these effector organs.

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THE USE OF CONTACT LENSES FOR AN ADOLESCENT PATIENT—A CASE REPORT*

John J. Wey†
Painesville, Ohio

L. S., 15, a student, consulted me on March 17, 1947, to see if there were some means whereby he might participate in sports to a greater extent without his heavy spectacles.

Examination revealed visual acuity O.D. 20/50, O.S. 20/50 requiring the following correction:

O.D. + 6.25 D. sph. ⌒ — 0.75 D. cyl. × 180. V.A. = 20/25.
O.S. + 6.25 D. sph. ⌒ — 0.75 D. cyl. × 180. V.A. = 20/25.

Patient referred to Cleveland Contact Lens and Visual Center for an examination to determine his suitability as a contact lens case. He passed this examination satisfactorily and was fitted with contact lenses which he now wears comfortably for 10 hours a day (in five hour periods) according to schedule. He reports that contact lenses permit him to participate in sports to an extent never previously attainable.

COMMENT

This case is presented to point out the great advantage to be had by fitting suitable contact lens patients at an early age. This patient is a very heavy set and robust individual, an ideal football prospect, except for his eyes. By obtaining contact lenses at an age which still permits him to learn the fundamentals of competitive sports (such as football, swimming, and wrestling) his entire outlook, personality, and pattern of life may change. If this patient had been told, as (unfortunately) many are being told, that "contact lenses are not developed sufficiently —wait a few more years", by the time he finally obtained contact lenses it would be too late to acquire the physical and mental coordination that may be gained through athletic participation.

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MODES IN MODERN EYE WEAR

As attention getters some of today's spectacle frames for women rival modern hats. From the elegant rimless models to the bizarre combinations of plastic, metal and jewels, each processed in many colors, women today can surely satisfy their fleeting taste in frames.

At no time in history has there ever been placed before women in need of visual aids a more gorgeous array of spectacle wear. No matter what her whim of the moment may be, the ingenious American frame maker has seen to it that the artistic frame she wants is there, in full choice of styles, colors, shapes and weights. From the gossamer rimless models to frames that surpass anything before offered in massive thickness. From crystal clear plastic to the sauciest of colors—vivid blues, reds,

violets, greens, and the more somber browns. All these are offered in not only solid colors but also fancy designs worked into the very fabric of the frame itself.

What an opportunity for the spectacle wearing girls and women of America! At last a chance to express their individuality in their choice of frame and at the same time achieve visual comfort. No longer is it necessary to apologize for wearing glasses or to develop an inferiority complex because of poor vision. Women wearing modern spectacles are actually the envy of many of their sisters who are blessed with visually efficient eyes.

Just where does the optometrist fit into this development? Some, we may be sure, seriously object to the unique idea of adding charm to a therapeutic aid. Others seem indifferent, while many view the current trend as something both interesting and of value to their patients and themselves.

Those who dissent take the position that many of these modern frames go too far and becomes mere fashion foibles. They feel the skill and care required in refracting and properly correcting the patients' ametropias are negated by the frame selected and the emphasis which is placed by the patient on personal appearance rather than visual efficiency. Dr. R. W. Tubesing, Editor of the INDIANA OPTOMETRIST, reflects this viewpoint when he asks the question, "Why be spectacular when bespectacled?"

The question of proper axis position and lens centering is also brought up as it is admittedly more difficult to correctly manufacture lenses in some of the unique shapes used today. Experienced laboratory executives assure us, however, that it is by no means impossible to do accurate work and experienced opticians have no objection to these shapes. This is, however, an important matter and Dr. Glenn A. Fry and others have already published rules and procedures to assist opticians in laying out blanks for this work, thus maintaining the high accuracy which generally has characterized the work of American opticians.

It is quite understandable that optometrists are at times concerned about this fashion trend in modern eye wear. As optometrists, most of our efforts are devoted to the prescribing of glasses and it is natural that the material end results of our efforts, the glasses themselves, are looked upon by us as highly technical aids to the patient and not to be lightly treated.

On the other hand, there is much to be said for the newer styles. In the first place, by making glasses attractive, thousands of women today

are wearing them who would perhaps go without them if they could not get the chic results which come from the use of modern frames. In other words, we must face the fact that with many women and some men, visual comfort is secondary to appearance. It always has been so and probably always will be. Optometrists who have practiced 30 or more years will admit that prior to World War I when there were only two or three different types of glasses, very few women between the ages of 15 and 35 wore them. Today this same group constitutes a large part of our practices.

And in addition, what right have we as optometrists to insist that our patients wear drab ultra-conservative frames if their tastes are otherwise. As professional people we have an obligation to prescribe as our knowledge dictates, but the patient who accepts our prescription without question, still must wear the frame which holds the prescription in the form of lenses. Most patients today are style conscious. This goes for men as well as women. The trend has long since gone too far for us to check and when the patients' frames are correctly fitted the featured style angle is really a matter of patient concern only.

For years we advised our patients to secure an extra pair of glasses telling them that those who need glasses should be fortified with a "spare." Much effort went into this with but meager results.

Today, however, the style angle has solved this problem at least with many of our younger women patients. Frequently these women have two or three entirely different sets of glasses made as each new prescription is written.

Whether we view with alarm or smile with indulgence at some of the newer creations in eye wear, we must admit in fairness that these add some additional zest to the work of the optometrist and assist in the overall health program of getting more corrections on more patients. They thus become an important part of the American eye care program and as such we will have to go along graciously and thankfully and at the same time enjoy the show. CAREL C. KOCH

CURRENT COMMENTS

Virginia Huck
Editorial Assistant

Optometrists will confer a favor by sending news items of general interest for this department: such as relate to new instruments, clinical techniques, education, visual health and optometric legislation and organization.

VISION AND HIGHWAY SAFETY

The Saturday Evening Post's article of August 16, "License To

Kill," written by David G. Wittels, caused a great deal of comment in optometric circles. In this article, Wittels deplores the ease with which a person can obtain a drivers' license in many states—a "license to kill," as he puts it.

The Journal agrees that author Wittels' report is food for sober thought. Too, we agree with A. O. A. President E. F. Richardson that every optometrist should read the article and realize his obligation to help curb highway accidents.

There is a danger, however, that too many optometrists, in attempting to help correct the situation, will put too much emphasis on working for state laws which will require near-normal vision as a requisite for obtaining a drivers' license. As the Journal sees it, this is not the solution to the problem. Rather, it is a mistake made too frequently in the past wherein well-meaning optometrists have demanded of legislative committees a high standard of visual performance for motor driving.

Optometrists must recognize two things: (1) drivers with average uncorrected visual problems can frequently drive a car with safety, and (2) vision is only one minor part in the whole program of highway safety.

With respect to visual problems, the facts are that a visual acuity of 20/60 in the better eye is adequate for highway safety, providing all other factors meet minimum requirements. In addition, it must be understood by those who crusade for stringent drivers' licensing laws, that the mere passing of tests does not in itself weed out the potentially dangerous driver, as no series of tests has yet been devised which will screen out the alcoholics and those inclined to take reckless chances.

From an optometric standpoint our societies should appoint delegates to serve on local safety council committees and there cooperate with other civic planners in the development of the soundest possible overall program. Visually, their recommendations should follow the pattern already set by Dr. A. R. Lauer, Director of Driving Research Laboratory, Iowa State College, Ames, Iowa, or that suggested by Dr. Earl Allgaier, of the American Automobile Association, Washington, D. C.

READER OPINION ON SPECIALIZATION

Recently in this department we posed the question, "Should one particular group determine who can or cannot be a specialist in certain forms of optometric work, or should we continue to drift along as at present?

Some readers expressed the opinion that a special group should be appointed to act as an examining board or "clearing house" for prospective specialists. Others felt the right to specialize should be conferred upon an optometrist by our schools after the optometrist had completed a postgraduate course.

The letter which we feel most effectively expressed the consensus of our readers came from Mr. Eric Bateman, noted British optometrist.[1]

Pointing out that the problem is also facing British practitioners, Mr. Bateman says in his letter, "In my opinion, from a long term viewpoint, every registered optometrist or ophthalmic optician should automatically be qualified in 'orthoptics' for the simple reason that orthoptics is a vast subject of which the physical correction of the eyes by lenses, is a part. It is within the borders of defined and legitimate optometry to include special techniques for functional re-education or binocular vision, if need be, without prescribing lenses."

The fitting of contact lenses is a different story, however, Mr. Bateman feels.

"This is a legitimate specialty, and postgraduate diplomas could be available in this sphere of activity."

Mr. Bateman also thinks that at present, many modern practitioners are not sufficiently distinguishable from the ancestral optician type.

"In both our countries, we have to face the fact that owing to rapid evolution—one might almost say revolution, which is consolidating our work on a true professional plane, some sort of 'interim' qualifications seem to be needed to distinguish the modern practitioner from the original prototype.

"In Great Britain, the British Optical Association has introduced a special examination to meet just this situation in both orthoptics and contact lens work. The former leads to a diploma (D. Orth.), the latter to a certificate (registered) contact lens practitioner.

"This, it seems to me, is a necessary compromise for a period of perhaps 20 to 30 years, by which time (we hope!) the optometrist will receive not less than five years training excluding art credits, and have stabilized his specialty within the Anglo-Saxon framework for all time," Mr. Bateman's letter concludes.

HEALTH PROGRAM WORRIES BRITISH LEADERS

Lawmakers and professional committees of Great Britain are now in the process of writing the regulations that will govern the work of

[1]Fellow, British Optical Association, (Hons.), Fellow, American Academy of Optometry.

British optometrists under the new health bill which goes into effect in 1948. While determination to cooperate with the government and make the plan work is evident, there also is a deepening anxiety over its ultimate results and especially its effect upon optometry in Great Britain, judging from the many editorials and reports appearing in the British optometric press. Each conference the British eye services committee holds with the men who are actually writing the regulations brings up new questions in optometric circles. British optometrists are asking: Will optometric service under the state scheme split into two parts—one part consisting of optometrists who work in the health centers, the other of optometrists who elect to stay in private practice? If so, will the two parts become competitive? Can Great Britain spare the manpower needed to staff its health centers adequately enough to avoid giving the public "assembly line" visual service? Can a system based on ophthalmologists being responsible for the care of the eyes and the optometrist doing refracting only as an associate, work smoothly? Will the good will built up between British ophthalmologists and optometrists be shattered because of this new system?

Practitioners in England are seeking the answers to these questions before the regulations are finalized, and on this side of the Atlantic we have more than a passing interest in the answers. The United States has as yet to devise an acceptable plan for complete medical care on a national basis, and for this reason, health groups and lawmakers alike are interested in seeing just how the socalistic British health plan will eventually work out.

THE NEW LOOK

Fashion has decreed that the American woman shall wear a "New Look" this fall—a look created by longer hemlines, padded hips, and rounded shoulder lines.

Not to be outdone by clothes stylists, optical manufacturers have designed glasses which will not only enhance the New Look but satisfy the ever-present feminine desire for the unusual and the beautiful.

Kono Manufacturing Company, Woodside, New York, has announced perfection of a method whereby dress material can be pressed between two parts of transparent zyle and presto! the frames match the dress. Until now, the fabric patterns were stamped or lithographed onto the surface of the frame.

Both beautiful and unique is the jeweled lens, "Julette," designed by the Cosmet Company, Minneapolis, Minnesota, to harmonize with either natural coloring or costume (ten colors are available). Tiny,

sparkling rhinestones are set by a special process along the upper edge of the cosmet-edged lens. The special process prevents the jewels from falling out of the lens and the jewels do not interfere with vision.

ANNOUNCEMENTS

DARTMOUTH EYE INSTITUTE CLOSES

The termination of the Dartmouth Eye Institute, Hanover, New Hampshire, was announced by the board of trustees on May 10, 1947, to be effective June 30, 1947. The primary reason for the curtailment of the research in physiological optics and related clinical work was insufficient funds to carry on the research program. For over 12 years, the Institute as a part of Dartmouth College had been supported largely by the Rockefeller Foundation Fund. Two years ago the Rockefeller grant ended. Despite contributions by other organizations and several grateful patients, sufficient moneys could not be obtained to maintain the activities of the Institute.

The Dartmouth Eye Institute evolved from the Department of Research in Physiological Optics of the Dartmouth Medical School which department owed its beginning to Adelbert Ames, who in 1910 gave up his Boston law practice for painting, an avocation which involved him in the visual aspects of art appreciation. In 1919, Ames consulted Charles Proctor, head of the Physics Department at Dartmouth College, about the problem of measuring the characteristics of the eye and reproducing it in the form of a camera-like replica. Professor Proctor encouraged Ames to work on the problem and gave him working space in his laboratory at Dartmouth.

With the assistance of Gordon Gliddon, a graduate of the Rochester School of Optometry and lens designer from Eastman Kodak Company, Ames built an optical replica of his own eyes and in so doing discovered a condition of inequality in the images of his eyes. This condition of unequal images became known as "aniseikonia" and with gradually increasing medical and optometric investigations has resulted in relief from eye discomfort and headaches for many people.

Important theoretical and practical assistance to the Ames' original work was given in the early 1930's by Gliddon, Dittmer, Ogle, Madigan, Imus, Neumueller, Carleton, etc. In 1935, Dr. A. A. Bielschowsky, noted German ophthalmologist, became director of the Eye Institute and the clinical and research activities gradually enlarged during the ensuing years. The publications of the Institute staff, including such

men as Herzau, Burian, Lindsz, Lancaster, Roper, Bannon, Bartley, as well as those mentioned previously, give testimony of the scope and productiveness of the Institute's accomplishments.

Dr. Bielschowsky's untimely death in January, 1940, was a shock to the Institute staff and its efforts. However, Dr. Walter B. Lancaster's appointment in late 1940 as chief of staff provided the Institute with the dean of American ophthalmologists and promised to carry the Institute's work to still further heights. The staff in 1941 numbered as many as 35 including five ophthalmologists and five optometrists. The rapport and cooperation between the ophthalmologists, optometrists, physicists, psychologists, mathematicians, etc., was excellent and it appeared that a unique institution of visual science with harmony among its members could contribute important material to science and to the welfare of humanity.

Unfortunately, in 1942, Dr. Lancaster resigned from the Dartmouth Eye Institute to resume private practice in Boston. This was a great loss to the clinical staff who had looked up to Dr. Lancaster as a leader and teacher.

Following Dr. Lancaster's resignation and during the war years, the Institute participated in research work for the government and continued to care for patient demands as well as its limited clinical staff allowed.

The contributions of the Dartmouth Eye Institute were primarily in the field of physiological optics—especially with respect to binocular vision, and aniseikonia. Professor Ames, who has always been interested in the perceptual aspects of vision, plans to continue his research relative to the nature and origin of visual sensations which is more in the province of psychology rather than physiological optics. The termination of the Dartmouth Eye Institute is to be regretted but, nevertheless, consolation may be taken in the realization that for over 15 years an institution composed of representatives of all fields of visual science, including optometry, added important information to our literature and aided in caring for many difficult ocular problems presented by patients from this country and abroad.

Instruments for the measurement of aniseikonia and iseikonic lenses for the correction of aniseikonia will continue to be made by the American Optical Company, which company has contributed generously for many years to the support of Dartmouth Eye Institute's research work. The examination for aniseikonia is now available at eight of the large ophthalmological institutions in this country, at two optometric schools; by four ophthalmologists in private practice and by 11 op-

tometrists in private practice. It is believed that these 25 aniseikonic practitioners are so distributed geographically that the public can be served adequately and the closing of the Dartmouth Eye Institute will not cause a significant handicap to patients requiring the aniseikonic examination.

The termination of the Rockefeller Foundation support implied that the research relative to aniseikonia has been completed satisfactorily and that further work is primarily clinical in nature. Nevertheless, it is hoped by those interested in the subject that some institution—possibly one of our optometric schools—will be able to carry on further investigations in aniseikonia and allied matters.

The numerous papers written by members of the staff may be available still to those interested by contacting the recent staff members at their addresses listed below:

A. Ames, Jr., Hanover, N. H.
Gordon H. Gliddon, Baker Library, Hanover, N. H.
Elmer H. Carleton, M.D., 4 Occum Ridge, Hanover, N. H.
Kenneth N. Ogle, Mayo Clinic, Division of Physics, Rochester, Minn.
Hermann M. Burian, M.D., 520 Commonwealth Avenue, Boston, Mass.
Robert E. Bannon, O.D., 46 Lebanon Street, Hanover, N. H.
Henry A. Imus, Box 503, R.F.S. 5, Wilton Woods, Alexandria, Va.
Walter B. Lancaster, M.D., 520 Commonwealth Avenue, Boston, Mass.
Arthur Linksz, M.D., 6 East 76th Street, New York, N. Y.
Kenneth L. Roper, M.D., 58 East Washington Street, Chicago 2, Ill.
Howard S. Bartley, Department of Psychology, Michigan State College, East Lansing, Mich.
Robert J. Beidel, Jr., 516 Walnut Street, Catawauqua, Pa.

To obtain copies of Ellerbrock's "Report on Survey of Optical Aids for Subnormal Vision," requests should be addressed to Mr. A. A. Bombe, Box 371, Roslyn, New York.

To obtain the complete copy of Bielschowsky's "Lectures on Motor Anomalies" and the Imus "An Evaluation of Visual Factors in Reading," requests should be addressed to Dartmouth College Publications, Hanover, New Hampshire.

Copies, if available, of papers of Alfred Bielschowsky, other than his "Lectures on Motor Anomalies," may be obtained from *The Hanover Institute*, Hanover, New Hampshire.

ROBERT E. BANNON.

SPECIAL REPORT

THE AMERICAN OPTOMETRIC FOUNDATION*

William C. Ezell†
Spartanburg, South Carolina

The American Optometric Foundation is designed to do just the type of things that the members of the Academy are interested in. The organizers of the foundation believe that it will be a great professionalizing agency when its purposes are translated into activities.

A foundation for optometry has long been needed. The idea at first was to assist students. Further study soon developed the fact that many other programs should and could be carried out through a properly and adequately supported foundation. Progress reports were made to the A. O. A. House of Delegates for the past four years and authorization for the establishment of a foundation was voted by the delegates. On June 21, 1947, the board of directors of the American Optometric Foundation met in Atlantic City. As a result of this meeting the articles of incorporation and by-laws were adopted and plans were made for launching of the foundation.

Briefly, the foundation was organized to receive money, both for the permanent endowment and for meeting the current expenses incident to the operation of the foundation, this money to be used for conducting the following projects:

To aid and assist worthy or exceptional students in the field of optometry, either in undergraduate or postgraduate study;

To advance and improve optometric education by aiding the schools and colleges of optometry and the students and teachers therein;

To assist in authoritative and impartial investigation and experimentation on optometric problems;

To assist in carrying on research in optometry and allied fields;

To encourage and assist graduate optometrists to establish themselves in accordance with the ethical standards of the profession;

To assist in the preparation of optometric textbooks.

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*Submitted on August 7, 1947 for publication in the September, 1947, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Optometrist, Fellow, American Academy of Optometry. President, American Optometric Foundation, Inc.

There are four classes of members: (1) The state associations, (2) Active members (any one individual who subscribes not less than fifteen dollars), (3) Life members (Those who contribute not less than five hundred dollars. These may be individuals or organizations), and (4) Honorary members.

The foundation is deliberately organized so that members are in control at all times. Each type of membership, except honorary, carries a vote. The state association members will elect one director, the active members will elect four directors and the life members will elect two directors.

While the American Optometric Association is organized for the direct protection of optometry and optometrists, the foundation is organized primarily for the benefit of humanity.

The active participation of all Academy members is solicited. It is hoped that every Academy member will become both a life and an active member and will assist in the campaign soon to be launched in every state for the support of the foundation. The Academy might well sponsor the foundation as one of its worthy activities. Some of the state associations, as well as other organizations, have already pledged life membership, and life membership by the Academy is solicited.

The following officers were elected to serve until the next annual meeting: president, Dr. William C. Ezell, Spartanburg, South Carolina; first vice president, Dr. John J. Brady, Sheldon, Iowa; second vice president, Dr. Walter I. Brown, New Bedford, Massachusetts; secretary, Dr. Harold V. Hutcheson, Tarrytown, New York; treasurer, Dr. Frederick A. Stengel, Marion, Ohio.

Directors of the foundation are: Dr. Leslie R. Burdette, Salem, Oregon, and Dr. Weston A. Pettey, Lubbock, Texas.

The American Optometric Foundation is organized pursuant to Membership Corporation Law of the State of New York.

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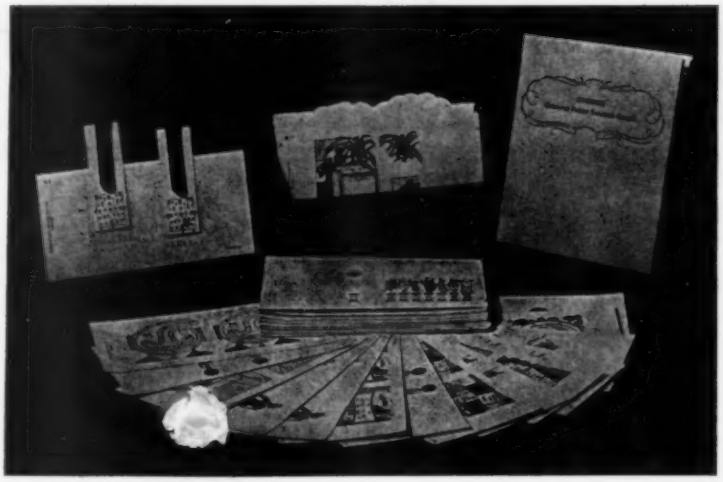

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